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Department of Registration and Education
STATE GEOLOGICAL SURVEY DIVISION
John C. Frye, Chief

GUIDE LEAFLET

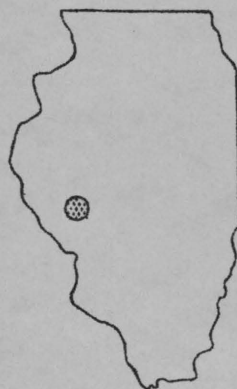
GEOLOGICAL SCIENCE FIELD TRIP

Sponsored by
ILLINOIS STATE GEOLOGICAL SURVEY, URBANA

WINCHESTER AREA

Scott, Morgan, and Greene Counties

Winchester and Griggsville Quadrangles



Leaders

William E. Cote, David L. Reinertsen, George M. Wilson, Myrna M. Killey
Urbana, Illinois
May 9, 1970

TO THE PARTICIPANTS:

The Geological Science Field Trip program is designed to acquaint Illinois residents with the landscape, the rock and mineral resources, and the geological processes that have led to their origin. With this program, we hope to stimulate a general interest in the geology of Illinois and a greater appreciation of the state's vast mineral resources and their importance to the over-all economy.

We encourage you to ask the tour leaders any questions that may occur to you during the trip. Discussion often clarifies points that otherwise would remain confused to many of the participants. We also invite your written comments upon the conduct of the trips so that we might improve them as much as possible.

Additional copies of this guide leaflet, as well as itineraries for field trips that have been held in the past, may be obtained free of charge by writing to the Illinois State Geological Survey. The itinerary maps for each field trip can be purchased for 10 cents each.

Several of the stops along this itinerary are located on private property whose owners have graciously given us permission to visit their lands. Please obey the instructions of your trip leaders and conduct yourselves in a manner that will show respect for the property owners' cooperation. Please do not litter, or climb on fences, and leave all gates as found, so that we may be welcome to return on future field trips. These simple rules of courtesy also apply to public property as well. For the convenience of those persons who may use this itinerary at some future time, the names and addresses of every private property owner are listed for the respective stops on a page at the back of this guide leaflet. Whenever possible, always attempt to obtain permission when visiting private property.

We hope that you enjoy today's field trip and will attend others in the future.

THE STAFF
EDUCATIONAL EXTENSION SECTION
ILLINOIS STATE GEOLOGICAL SURVEY

WINCHESTER GEOLOGICAL SCIENCE FIELD TRIP

INTRODUCTION

The Winchester area is situated near the bluffs of the Illinois Valley in Scott County, western Illinois. The area was covered all or in part by continental ice sheets during the Kansan and Illinoian glaciations, the second and third glacial intervals of the Great Ice Age. Illinoian drift, consisting of till and outwash deposited some time between 250 and 200 thousand years ago, occurs extensively over the bedrock surface throughout the area and is exposed at many places. Deposits of the earlier Kansan glacier occur beneath the younger Illinoian drift, but exposures are rare. Apparently the Kansan drift is thin and patchy in occurrence because of post-Kansan erosion, as well as erosion by the Illinoian glacier. The last glacier to invade Illinois, the Wisconsinan, did not reach the Winchester area, but thick outwash sand and gravel, deposited by meltwater from this glaciation, are present in the Illinois Valley. Thick deposits of Wisconsinan loess, windblown silt that was derived from this outwash, mantle the bluffs of Illinois Valley and the upland to the east, forming the surficial material throughout the field trip area.

Physiographically the field trip area lies near the western edge of the area covered by the Illinoian ice. It occupies the portion of the Illinoian till plain called the Springfield Plain (see attached map of Physiographic Divisions of Illinois). The present topography of this region is mainly the result of the deposition of drift by the Illinoian glacier, the deposition of the thick Wisconsinan loess, and the subsequent erosion and stream dissection of these deposits during post-Illinoian and post-Wisconsinan times. The glacial deposits are quite thick, as much as 100 feet near the Illinois Valley bluffs and commonly 50 feet or more on the upland to the east, so that the irregularities of the bedrock surface have little influence on the topography. The upland is highly undulating and well-drained with numerous valleys cut deeply into the till plain surface. Remnants of the till plain are preserved as narrow, even to gently undulating interstream areas (see Itinerary Map). The Illinois Valley is the most prominent topographic feature in the field trip area, its broad, flat bottom contrasting sharply with the highly undulating upland terrain. The valley walls, which rise abruptly 100 to 200 feet above the floodplain, are smoothly rounded for most of their extent because of the thick loess cover, but sheer limestone cliffs are present in the extreme southern part of the field trip area.

The much older, consolidated bedrock that underlies the glacial deposits in the field trip area consists of approximately 3,500 feet of sedimentary strata (fig. 1). These strata consist mainly of sandstone, shale, limestone, and dolomite that were deposited layer by layer in the ancient shallow seas that invaded the mid-continent region during the Paleozoic Era, between 550 and 270 million years ago. The Paleozoic strata are divided into major subdivisions known as systems, each of which was deposited during a specified period of geologic time. The systems are in turn subdivided into many formations on the basis of mineral composition and fossil content. The uppermost 450 feet of these sedimentary strata, including formations of the Pennsylvanian and Mississippian Systems, are exposed in the Winchester area (fig. 2). Older formations of Devonian, Silurian, Ordovician, and Cambrian ages are known from deep wells that penetrate them and from other areas in Illinois where they are exposed at the surface. The base of the Cambrian strata rests upon an ancient basement of Precambrian igneous and metamorphic rocks that are more than one billion years old.

Geologically the Winchester area is situated on the western shelf of the Illinois Basin, a large, spoon-shaped bedrock structure that underlies most of






















SYSTEM	SERIES	GROUP, STAGE	FORMATION, MEMBER	ROCK TYPE	MAX. THICK- NESS	DESCRIPTION
QUATERNARY	Pleistocene	Recent			40	Alluvial sand, silt, clay; dune sand
		Wisconsinan	Peoria		50 75	Loess, eolian sand; outwash sand and gravel
			Roxana		40 60	Loess, eolian sand; outwash sand and gravel
		Illinoian			60	Till; outwash gravel, sand, silt, clay
		Kansan ?			10	Till; outwash sand, silt
PENN.		Kewanee	Pleasantview Ss. No. 2 Coal- Seahorne Ls.	 	105 15	Sandstone, shale, limestone, coal, underclay Limestone, clay, shale
MISSISSIPPIAN	Valmeyeran		St. Louis		15	Limestone
			Salem		35	Limestone, dolomitic
			Sonora			
			Warsaw		100	Shale, dolomite, sandstone; geodes
			Keokuk- Burlington		170	Limestone, dolomitic; very cherty
			Fern Glen		5	Limestone, cherty; shale
			Hannibal		40	Shale
DEVO- NIAN	Kind.	New Albany	Saverton Grassy Creek Sweetland Crk.		110	Shale
SILURIAN	Niag. A.				135	Limestone, dolomite; some chert
ORDOVICIAN	Cincinnatian	Maquoketa			175	Shale, siltstone; some limestone and dolomite
	Champlainian	Galena			190	Limestone; some chert
		Platteville			150	Dolomite, limestone, some chert
OLDER ORDOVICIAN AND CAMBRIAN STRATA			(Undiffer- entiated)		2250	Dolomite, limestone, sandstone, shale
PRECAMBRIAN						Granite; other igneous and metamorphic rocks

Fig. 1 - Generalized geologic column of strata in the Winchester area.

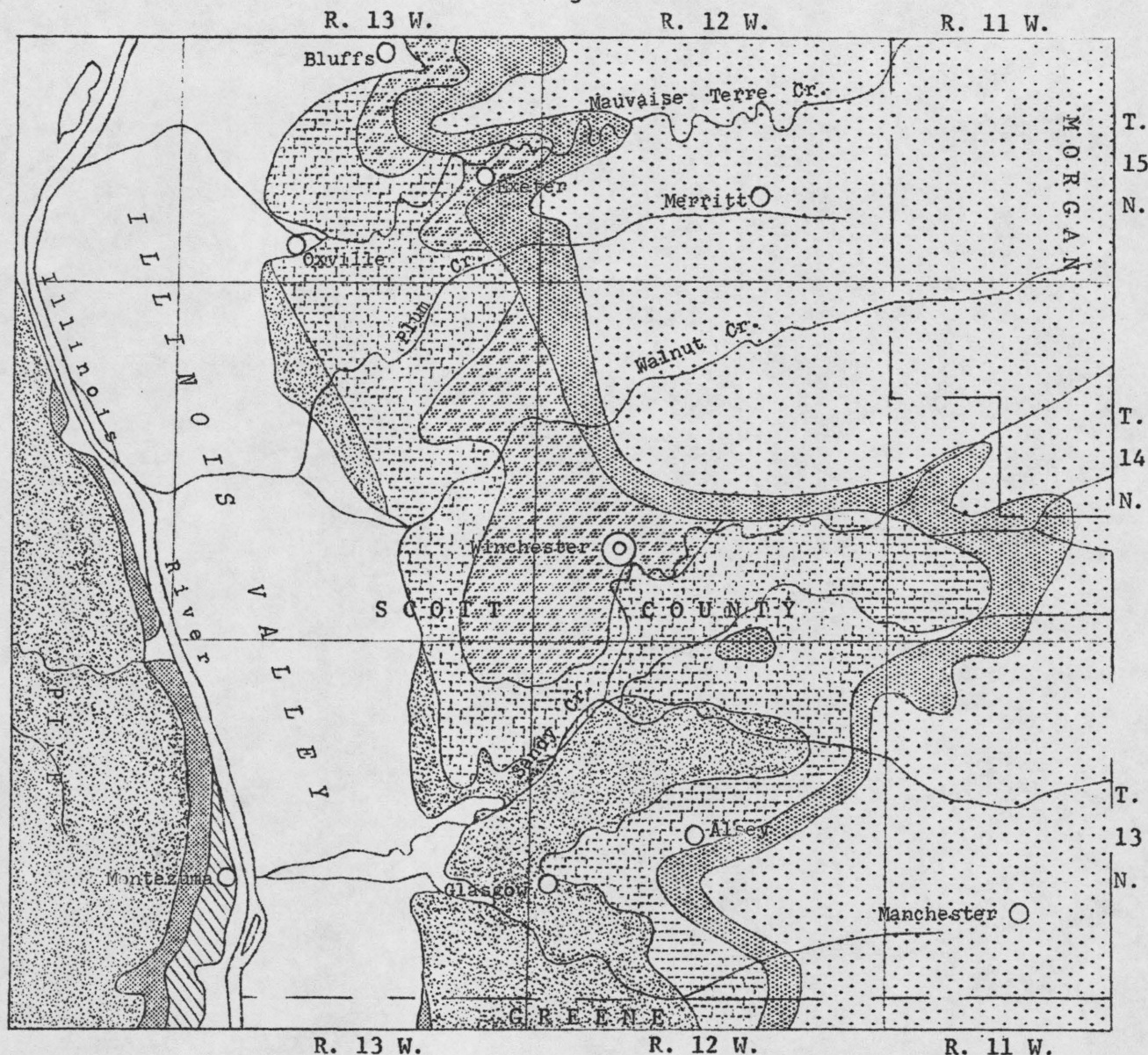


Fig. 2 - Geologic map of the bedrock formations in the Winchester area.

Illinois and adjacent parts of Indiana and Kentucky (figs. 3 and 4). Regionally the bedrock formations in the field trip area are tilted gently down to the east and southeast toward the deepest parts of the Illinois Basin. Westward they rise onto the northern flank of the Pittsfield Anticline, an arch of the bedrock that extends westward into Pike County, and onto the Mississippi River Arch, a broad bedrock uplift in extreme western Illinois (fig. 4). As the Illinois Basin was forming during the Paleozoic Era, it was gradually filled with the Paleozoic sedimentary rocks. Toward the deepest part of the basin in extreme southeastern Illinois, the Paleozoic rocks thicken to more than 13,000 feet. The Pennsylvanian rocks are the youngest Paleozoic strata in the basin and may represent the last of the marine invasions during the Paleozoic Era. However, marine conditions probably persisted into the Permian Period, the sea finally withdrawing from the Illinois Basin for the last time at the end of the Paleozoic Era about 225 million years ago. Since then most of the region has remained above sea level exposed to erosion. During this long interval of erosion, all of the Permian strata and a considerable thickness of the Pennsylvanian were removed. The nearest rocks of Permian age occur in eastern Kansas 325 miles to the west.

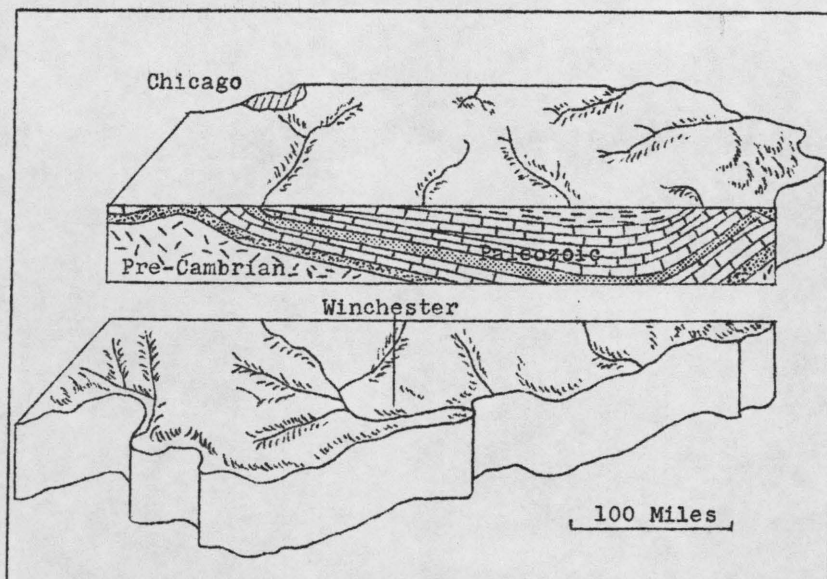


Fig. 3 - North-south cross-section through Illinois showing the Paleozoic strata in the Illinois Basin.

Brief invasions of the sea reached northward from the Gulf of Mexico to submerge the southern tip of Illinois during the Cretaceous Period of the Mesozoic Era about 100 million years ago and again during the early part of the Tertiary Period of the Cenozoic Era about 60 million years ago (see attached Geologic Map of Illinois). These marine invasions did not reach as far as the Winchester area. Sand and gravel deposits of Cretaceous age occur in Pike County 20 miles to the west, but these are apparently nonmarine, alluvial sediments.

in the field trip area include limestone for roadstone and agricultural lime, clay for refractory bricks, and glacial sand for use in the construction industry. Coal, which has been mined in the past, is still a potentially valuable mineral resource.

Important mineral commodities that are being exploited

Glacial History of Illinois

During the Pleistocene Epoch, commonly referred to as "The Great Ice Age," an extensive continental ice cap developed in the northern hemisphere during times when the mean annual temperatures were a few degrees cooler than they are now. The portion of the ice cap that intermittently covered northern North America has been named the Laurentide Ice Sheet. Beginning about 1 million years ago and ending only 5,000 years ago, southward expansions of the ice sheet caused four major glacial invasions of Illinois and the Midwest. The ice that entered Illinois came from

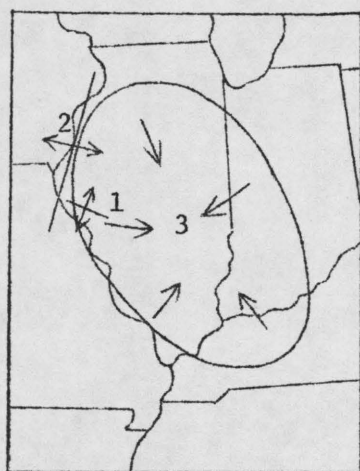


Fig. 4 - Index map with locations of (1) Pittsfield Anticline, (2) Mississippi River Arch, and (3) Illinois Basin.

centers in central and eastern Canada (fig. 5). Each of the four major glacial advances were followed by long, warm interglacial intervals during which the glaciers melted completely away (see attached Pleistocene Time Table). During these intervals, the deposits left by the glaciers were eroded and weathered. Each of the glacial advances produced significant changes in the topography and drainage of the glaciated areas. In order of occurrence, the glaciations of the Midwest have been named the Nebraskan, the Kansan, the Illinoian, and the Wisconsinan (fig. 6). The names are derived from the states where glacial deposits of these ages are best developed or were first described. The last glacier, the Wisconsinan, melted from northeastern Illinois a mere 12,000 years ago.

The Pleistocene glaciers profoundly modified the landscape of Illinois. They transported vast amounts of rock and soil debris that were eroded from the areas over which they moved. As the glaciers advanced and later melted back, these materials, known as drift, were deposited. Within the areas that were covered by the ice, there are extensive surficial deposits of ice-laid material called till. Areas that were covered several times by glaciers may have more than one layer



Fig. 5 - Maximum extent of the Laurentide Ice Sheet. The Keweenaw (K) and the Labradorean (L) centers are shown.

of till. Till is an unsorted, unstratified mixture of all sizes of rock debris that generally has the consistency of pebbly clay. Numerous arcuate till ridges called end moraines were formed at the margin of the Wisconsinan glacier in northeastern Illinois (see Glacial Map of Northeastern Illinois). Each end moraine represents an advance of the glacier and a line along which the ice margin maintained a temporary fixed position. The moraines were built up by accumulation of rock debris carried forward to the melting ice front. Thinner deposits of till that form gently undulating plains between the end moraines are known as ground moraines or till plains.

Sorted and stratified water-laid materials known as outwash, consisting of clay, silt, sand, and gravel, were also deposited as a result of the glaciations. Outwash sediments were deposited by debris-laden meltwater flowing away from the ice fronts during both the advances and retreats of the glaciers. Near the glacial margins, where meltwater was often not confined to definite channels, the outwash was laid as thin

blanket-like deposits called outwash plains. In some places, elongated ridges of sand and gravel represent channel deposits of meltwater streams that flowed on or under the glaciers. Conical mounds of outwash, called kames, were formed where meltwater plunged through crevasses in the ice or into ponds along the edge of the glacier. Glacial lakes formed by the ponding of meltwater in valleys, in low areas on till plains and behind end moraines were also the sites of deposition of the finest outwash sediments. Outwash deposits were often overridden by the advancing glaciers, so that the drift deposits typically consist of interstratified layers of till and outwash. There is also interfingering of these materials laterally.

River valleys, such as the Mississippi, Illinois, and Ohio, provided major channelways for escaping meltwaters. These valleys were greatly widened and deepened in the bedrock during times of greatest meltwater floods. When the floodwaters were waning, the valleys were partially filled with outwash far beyond the ice margins. The outwash deposits, consisting largely of sand and gravel, are known as valley trains. For example, along much of its length, the valley train of Mississippi Valley is more than 200 feet thick. In the Winchester area, the valley train of Wisconsinan outwash in the Illinois Valley is at least 150 feet thick. Many former river valleys in areas covered by the glaciers were completely filled and buried by glacial deposits. The meltwaters also cut new valleys and caused numerous changes in the drainage system, some temporary and some permanent.

Deposits of wind-blown silt, called loess, which form the surface materials over most of Illinois, are also the result of glaciation. The silt was blown from floodplains of the valley trains. Most loess deposition occurred in the fall and winter seasons, when colder conditions caused meltwater floods to recede, exposing the surfaces of the valley trains and permitting them to dry out. During Pleistocene time, as now, the winds prevailed westerly, and as a result, the loess deposits are thickest on the east sides of the source valleys. The loess thins rapidly away from the valleys. The loess is as much as 80 feet thick on the east bluff of the Mississippi Valley west of Winchester. The valley train of the Illinois Valley was the principal source of loess for this area.

Depositional History of the Mississippian Sedimentary Rocks

Valmeyeran (middle Mississippian) formations form the bedrock surface over much of the Winchester area (fig. 2). These strata form part of a thick sequence of Mississippian rocks that occur in the upper Mississippi Valley. The Mississippian formations in this region have a total cumulative thickness of more than 2,000 feet and form the type section for which the Mississippian System of rocks was named. These rocks are predominantly marine limestones and most of them are richly fossiliferous.

During the Mississippian Period, some 350 to 310 million years ago, the mid-continent of North America was a low-lying, stable platform. Throughout the Mississippian Period, as during most of the Paleozoic Era, the Illinois Basin was a slowly subsiding (sinking) area on this platform in which thick marine strata accumulated. The continental platform was submerged many times by marine invasions during the Cambrian, Ordovician, Silurian, and Devonian Periods. At the close of the Devonian Period the region remained submerged, and with the beginning of the Mississippian Period the shore lay just to the north and northeast of the Illinois Basin. At this time mud was being delivered into the sea by rivers flowing from the north and northeast. As a result the Kinderhookian formations consist mainly of shale and siltstone (fig. 1). Later during early Valmeyeran (middle Mississippian) time the sea on the western shelf of the basin, including the Winchester area, remained clear and mud-free most of the time. In this region the thick Burlington and Keokuk Limestones were deposited. These limestones accumulated in shallow water as a high bank of crinoidal carbonate debris that bordered the deeper part of the

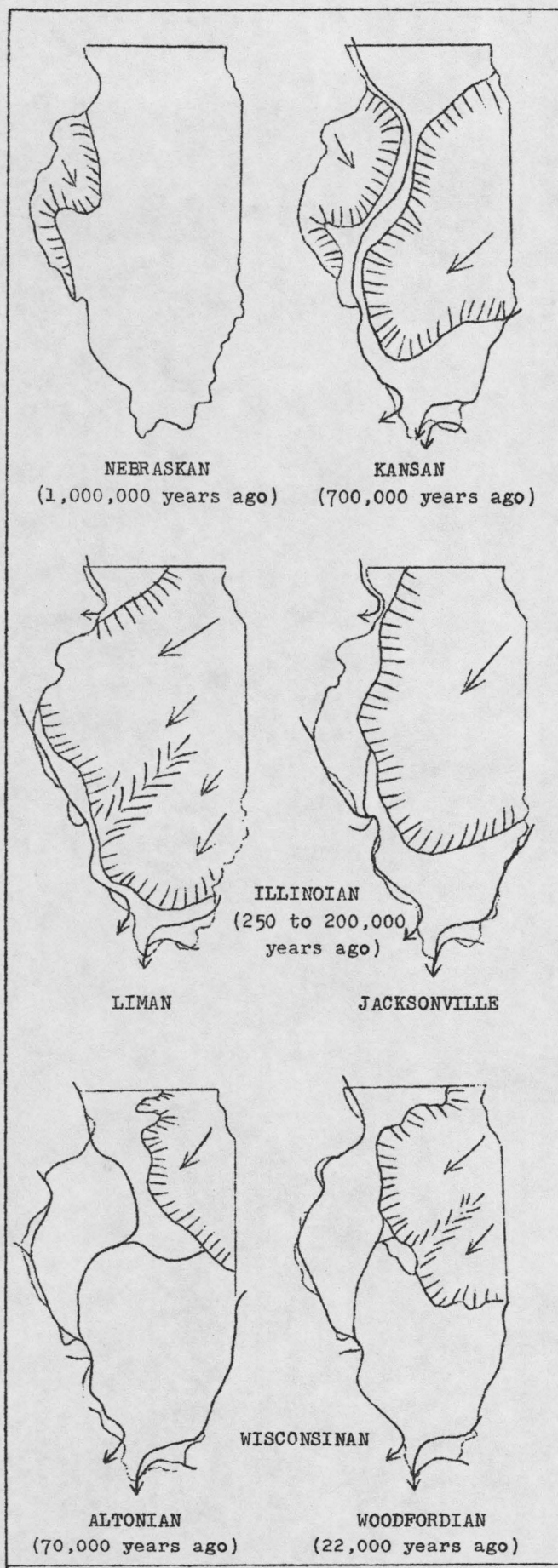


Fig. 6 - Sketch maps showing the extent of the major glacial advances into Illinois during the Pleistocene Epoch. Approximate times of invasion are given. Two substages of the Illinoian--the Liman and the Jacksonville--and two substages of the Wisconsinan--the Altonian and the Woodfordian--are shown. Arrows indicate the direction of ice movement and meltwater flow in major valleys that drained the ice fronts.

basin to the southwest where some mud continued to be deposited.

Later in Valmeyeran time the sea in the field trip area again became muddy, and the shale and impure limestone and dolomite of the Warsaw Formation were laid down. The muddy sediments of the Warsaw were derived mainly from the east where a great river was building a delta of sand and silt southwestward across Illinois into the deeper part of the Illinois Basin. As the delta extended westward and was built higher, muddy sediments spilled over the edge of the Burlington-Keokuk crinoidal bank onto the western shelf of the basin. Some muddy sediments were also delivered to the western shelf by rivers from the north and northwest. Near the end of Warsaw deposition these rivers transported much sand into this region, and the quartz sandstone and sandy dolomite of the Sonora Formation were deposited. This sandy formation interfingers with the upper part of the Warsaw Formation and the lower part of the younger Salem Limestone in western Illinois and eastern Iowa. The Mississippian sea then extended far to the north, and for the remainder of Valmeyeran time little mud and sand were deposited in the Winchester area. The relatively pure Salem and St. Louis Limestones were deposited over enormous areas of the continental platform.

The clear, warm sea in which the Valmeyeran limestones were deposited in the Winchester area was fairly shallow, probably only a hundred or so feet deep generally, and at times only a few tens of feet and less. Marine animals found the shallow sea ideal for their development. Portions of these limestones consist almost entirely of cemented fossils and fossil fragments, limestone fragments, or oolites, which indicate shallow-water, wave-swept conditions of deposition. Mats and crusts of algal limestone, formed by microscopic, calcium carbonate-secreting algae (primitive plants) are also indicative of shoal environments.

The Ste. Genevieve Limestone which occurs above the St. Louis Limestone to the south and southeast was also deposited in the Winchester area, as was a thick section of strata belonging to the Chesterian Series (upper Mississippian; see attached Geologic Map of Illinois). However, the Chesterian strata, the Ste. Genevieve Limestone, and most of the St. Louis Limestone have been stripped away by erosion. This erosion occurred principally during an interval of emergence that followed the final withdrawal of the Mississippian sea at the end of Chesterian time and preceded the deposition of the Pennsylvanian rocks.

During the latter part of the Mississippian Period (Chesterian time) the sea was more restricted in extent than when the Valmeyeran limestones were deposited. The shoreline shifted southward and increased amounts of sand and mud were delivered into the Illinois Basin by an ancient river system called the Michigan River. This river system drained a land area to the north and northeast in southern Canada. A great delta much like the present-day Mississippi River delta in Louisiana was built out into the sea. Under the influence of this deltaic environment the amounts of sand and mud carried into the sea fluctuated. As a result the Chesterian formations consist of regular alternations of sandstone, shale, and limestone. The sandstones and shales record times when the delta extended far out into the sea, while limestones record times when the shoreline receded to the north. In many respects the Chesterian formations resemble the cyclic sediments of the Pennsylvanian System, which overlie the Mississippian strata. Thin coal seams in some of the upper Chesterian sandstones indicate times when the sea withdrew temporarily and plant debris accumulated in fresh-water swamps on the delta. These late Mississippian coal swamps were forerunners of those that occurred more extensively later during the Pennsylvanian Period.

Depositional History of the Pennsylvanian Rocks

Pennsylvanian strata form the surficial bedrock in the eastern part of the field trip area (fig. 2). These rocks belong to the Spoon and Carbondale Formations. At one time these formations completely covered the field trip area, but they have been removed by post-Pennsylvanian erosion.

At the close of the Mississippian Period about 310 million years ago, the Mississippian sea withdrew from the midcontinent region. A long interval of erosion took place early in Pennsylvanian time. This erosion removed hundreds of feet of the Chesterian strata, completely stripping them away and cutting into older rocks over large areas of the Midwest. An ancient river system, descendant of the Michigan River, cut deep channels into the bedrock surface. Erosion was interrupted by the invasion of the early Pennsylvanian sea.

Depositional conditions in the Illinois Basin during the Pennsylvanian Period were similar to those that existed during late Mississippian time. The Pennsylvanian river system flowed southwestward across a low, swampy lowland, carrying mud and sand from northern highlands. Another great delta was built out into the shallow sea (fig. 7). The lowland stood only a few feet above sea level, so that only slight changes in relative sea level caused great shifts in the position of the shoreline.

Throughout Pennsylvanian time the Illinois Basin continued to subside. As during Chesterian time, the delta front continually shifted northward and southward due to worldwide sea level changes, intermittent subsidence of the basin, and variations in the amounts of sediment carried seaward from the land. The areas of land and sea continually changed as the shoreline shifted northward and southward. These alternations between marine and nonmarine conditions were more drastic and frequent than during Chesterian time, producing the even more striking lithologic variations in the Pennsylvanian rocks.

Conditions at various places on the shallow sea floor favored the deposition of sandstone, limestone, or shale. Sandstone was deposited near the mouths of distributary channels. These sands were reworked by waves and spread as thin sheets near the shore. The shales were deposited in quiet water areas--in delta bays between distributaries, in lagoons behind barrier bars, and in deeper water beyond the nearshore zone of sand deposition. Limestone, which formed by chemical precipitation from the sea and the accumulation of limy shells of marine plants and animals, was usually deposited farther from shore than the sandstone and shale, but some limestone was formed in nearshore areas where little sand and mud were being deposited. The areas of sandstone, shale, and limestone deposition continually changed as the position of the shoreline changed and as the delta distributaries extended seaward or shifted their positions laterally along the shore.

Nonmarine sandstones, shales, and limestones were deposited on the deltaic lowland bordering the sea. The nonmarine sandstones were deposited in distributary channels, in river channels, and on the broad floodplains of the rivers. Some sand bodies, 100 or more feet thick, cut through many of the underlying rock units. The shales were deposited mainly on floodplains. Fresh-water limestones and some shales were deposited locally in fresh-water lakes and swamps. The coals were formed by the accumulation of plant material, usually where it grew, beneath the quiet waters of extensive swamps which prevailed for long intervals on the emergent delta lowland. Lush forest vegetation, which thrived in the warm, moist Pennsylvanian climate, covered the region. The origin of the underclays beneath the coals is not exactly known, but they were probably deposited in the swamps as slackwater muds before and

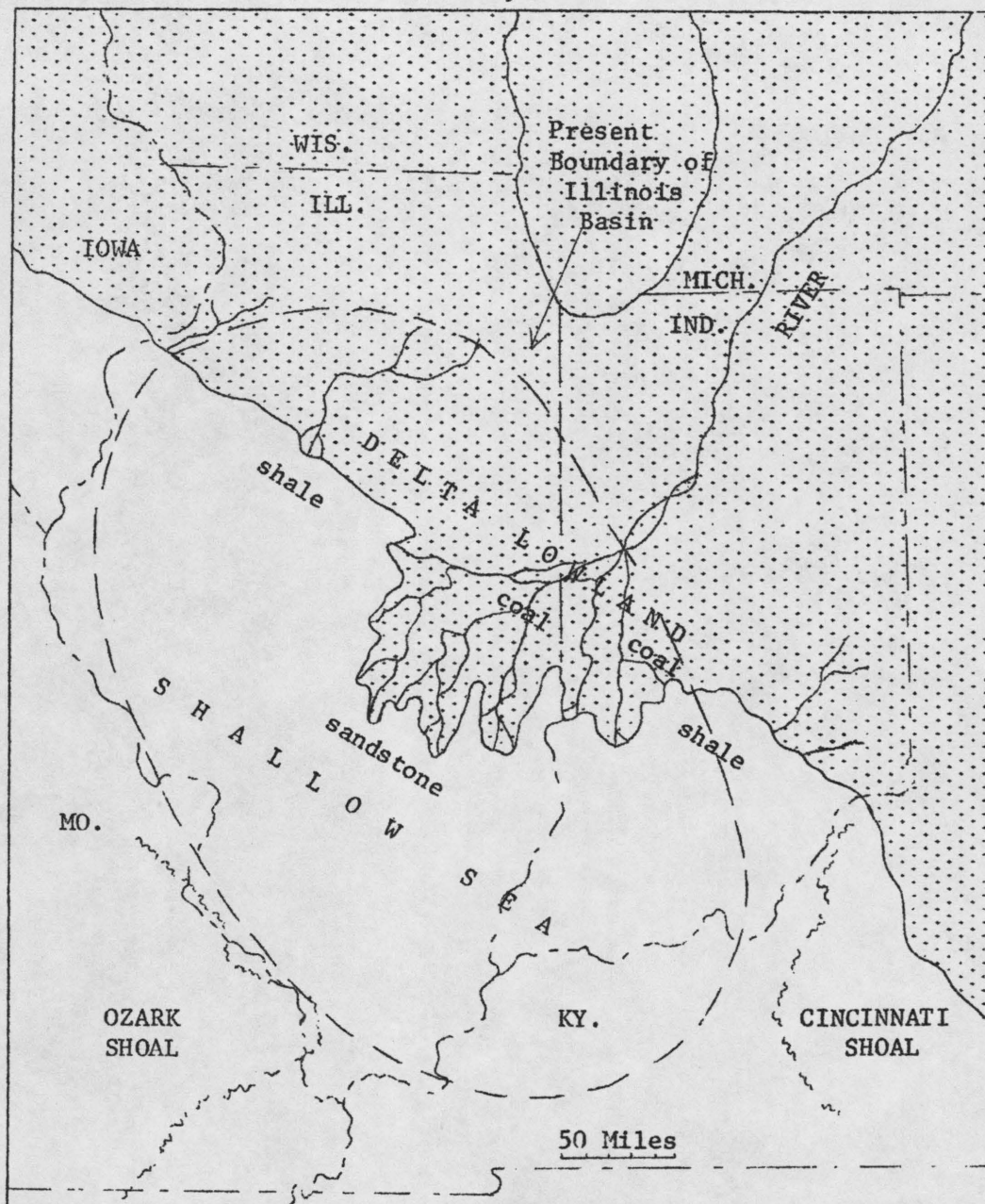


Fig. 7 - Paleogeography of Illinois-Indiana region during Pennsylvanian time. The diagram shows the Pennsylvanian river delta and the position of the shoreline and the sea at an instant of time during the Pennsylvanian Period.

during the formation of the coals. The formation of coal marked the end of the non-marine portion of the depositional cycle. Resubmergence of the borderland by the sea interrupted nonmarine deposition, and marine sediments were then laid down over the coal.

Pennsylvanian Cyclothems

Because of the extremely variable environmental conditions under which they formed, the Pennsylvanian strata exhibit extraordinary variations in thickness and composition, both laterally and vertically. Individual sedimentary units, usually

very thin and often only a few inches thick, rarely exceed 30 feet in thickness. Sandstones, shales, limestones, and coals grade laterally into one another. However, a few of the coals and several of the limestones can be traced in the subsurface over large areas of the Midwest.

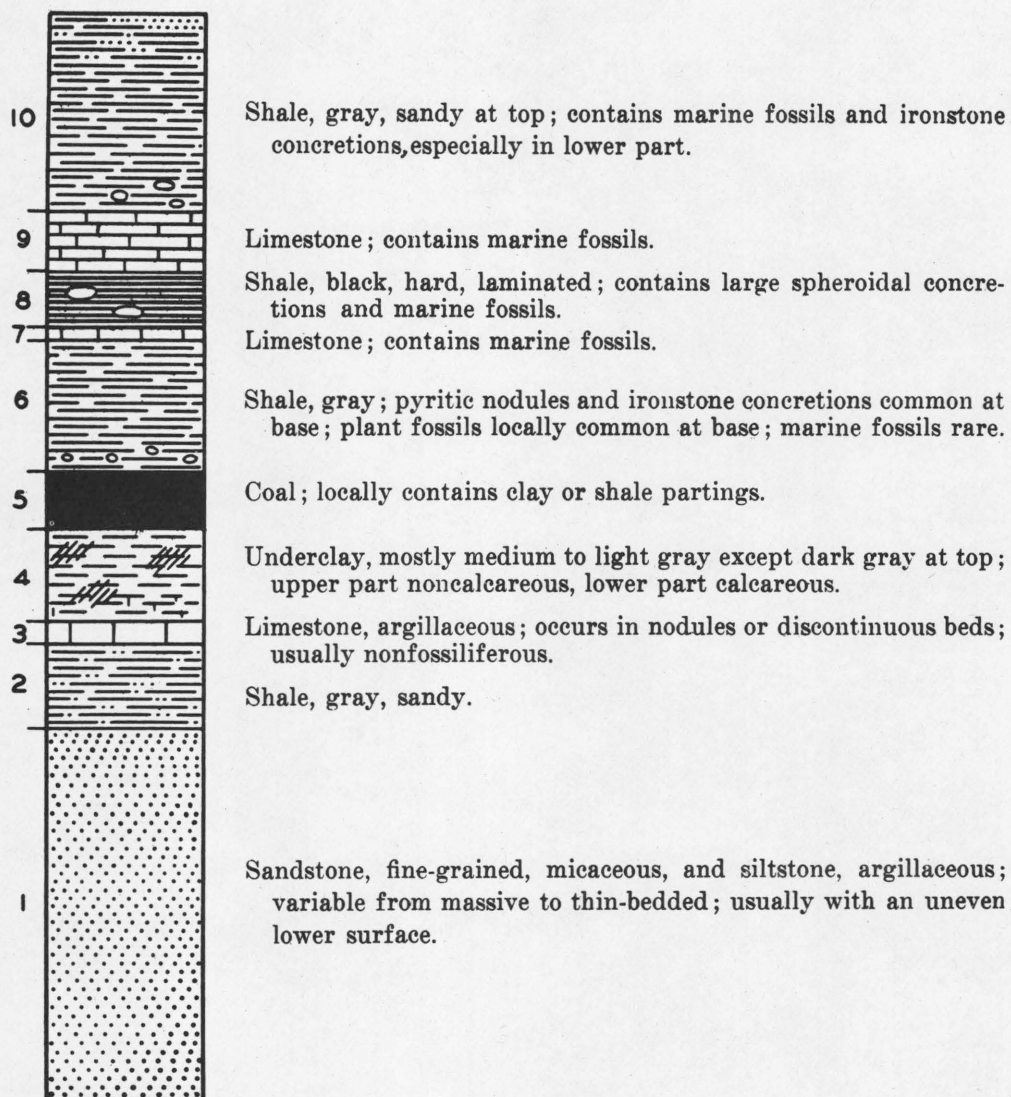
The rapid and frequent changes in depositional environments during Pennsylvanian time produced regular or cyclical alternations of sandstone, shale, limestone, and coal in response to the shifting front of the Pennsylvanian delta. Each alternation or cycle, called a cyclothem, consists of several marine and nonmarine rock units which record a complete cycle of marine invasion and retreat. Based on extensive studies of the Pennsylvanian strata in the Midwest, geologists have determined that an ideally complete cyclothem consists of ten sedimentary units. The chart on the next page shows the arrangement. Approximately 50 cyclothem have been described in the Illinois Basin, but only a few contain all ten units. Usually one or more are missing because conditions of deposition were more variable than indicated by the ideal cyclothem. However, the order of units in every cyclothem is almost always the same. A typical cyclothem includes a basal sandstone overlain by an underclay, coal, black shaly shale, marine limestone, and gray marine shale. In general the sandstone-underclay-coal portion (the lower 5 units) of each cyclothem is nonmarine and was deposited on the coastal lowlands from which the sea had withdrawn. However, some of the sandstones are entirely or partially marine. The units above the coal are marine sediments and were deposited when the sea advanced over the delta lowland.

Origin of Coal

It is generally accepted that the Pennsylvanian coals originated by the accumulation of vegetable matter, usually in place, beneath the waters of extensive, shallow, fresh to brackish swamps. They represent the last-formed deposits of the nonmarine portions of the cyclothem. The swamps occupied vast areas of the deltaic coastal lowland, which bordered the shallow Pennsylvanian sea. A luxuriant growth of forest plants, many quite different from the plants of today, flourished in the warm Pennsylvanian climate. Today's common deciduous trees were not present, and the flowering plants had not yet evolved. Instead the jungle-like forests were dominated by giant ancestors of presently-existing club-mosses, horsetails, ferns, conifers, and cycads. The undergrowth also was well developed, consisting of many ferns, fernlike plants, and small club-mosses. Most of the plant fossils found in the coals and associated sedimentary rocks show no annual growth rings, suggesting rapid growth rates and lack of seasonal climatic variations. Many of the Pennsylvanian plants, such as the seed ferns, became extinct.

Plant debris from the rapidly growing swamp forests, composed of leaves, twigs, branches, and logs, accumulated as thick mats of peat on the floors of the swamps. Normally, vegetable matter rapidly decays by oxidation to water, nitrogen, and carbon dioxide. However, the cover of swamp waters, which were probably stagnant and low in oxygen, prevented the complete oxidation and decay of the peat deposits.

The periodic invasions of the Pennsylvanian sea across the coastal swamps killed the Pennsylvanian forests and initiated marine conditions of deposition. The peat deposits were buried by marine sediments. Following burial, the peat deposits became gradually transformed into coal by slow chemical and physical changes in which pressure (compaction by the enormous weight of overlying sedimentary layers), heat (also due to deep burial), and time were the most important factors. Water and volatile substances (nitrogen, hydrogen, and oxygen) were slowly driven off during the coalification process, and the peat deposits were changed into coal.



AN IDEALLY COMPLETE CYCLOTHEM

(Reprinted from Fig. 42, Bulletin No. 66, Geology and Mineral Resources of the Marseilles, Ottawa, and Streater Quadrangles, by H. B. Willman and J. Norman Payne)

Coals have been classified by ranks which depend on the degree of coalification. The commonly recognized ranks of coal, in order of increasing rank, are (1) brown coal or lignite, (2) sub-bituminous, (3) bituminous, (4) semibituminous, (5) semianthracite, and (6) anthracite. Each higher rank is characterized by increasing amounts of fixed carbon and decreasing amounts of oxygen and other volatiles. Hardness of coal also increases with increasing rank. All of Illinois' coals are bituminous.

Underclays occur beneath most of the coals in Illinois. Because underclays are generally unstratified (unlayered), are leached and possess a bleached appearance, and generally contain plant roots, many geologists consider them to represent the ancient soils on which the coal-forming plants grew.

The exact origin of the carbonaceous black shales, which occur above many coals, is uncertain. The black shales probably are deposits which formed under restricted marine (lagoonal) conditions during the initial part of the invasion cycle, when the region was partially closed off from the open sea. In any case they were deposited in quiet water areas where very fine, iron-rich muds and finely-divided plant debris were washed in from the land. The high organic content of the black shales is also in part due to the carbonaceous remains of plants and animals that lived in the lagoons. The fossil remains of animals in the black shales are sometimes depauperate (dwarf) because they were stunted by toxic conditions in the sulfide-rich waters of the lagoons. The phosphatic siderite nodules, which occur in the black shales, were formed by chemical precipitation of calcium carbonate, iron carbonate (siderite), and phosphate from the brackish lagoonal waters. These features suggest slow rates of shale deposition.

ITINERARY

0.0 0.0 Assemble on west side of Winchester High School. Proceed north.

STOP. Turn left (west).

0.1 0.1 Railroad crossing.

0.25 0.35 STOP. T-road. Turn right (north).

0.15 0.5 STOP. T-road with Route 106. Turn left (west).

0.2 0.7 STOP. Intersection with Routes 36 and 54. Turn left (west).

2.3 3.0 Cross creek.

0.5 3.5 Mississippian Salem Limestone exposed in roadcut.

0.2 3.7 Enter Illinois Valley. Continue ahead on Route 36.

0.3 4.0 Cross low sand ridge. Note the sand pits on both sides of road.

0.25 4.25 Crossroads. Continue ahead.

Prepare to turn right.

0.1 4.35 Turn right (north) on haulage road to sand pit.

0.15 4.5 Stop 1. Sand pit in terrace remnant in Illinois Valley (NE 1/4 SW 1/4 NW 1/4, Sec. 27, T. 14 N., R. 13 W.).

This sand pit is excavated in Pleistocene alluvial sands of Woodfordian (Wisconsinan) age that were deposited by glacial meltwater of the Valparaiso glacier about 14,000 years ago. The sand exposed here forms part of a low, elongate sand ridge that extends northwestward from this vicinity for about 1.5 miles (see Itinerary Map). This ridge and similar, lower sand ridges upvalley from here occur on and form part of a series of eroded terrace remnants along the east side of the Illinois Valley. The surfaces of the terrace remnants are highly undulating and stand at elevations ranging from 440 to 465 feet above sea level or 10 to 30 feet above the level of the present floodplain. Generally the terrace slopes gently down to the level of the valley bottom. The top of the ridge here at Stop 1 reaches 465 feet and is probably close to the level to which the valley train once filled the Illinois Valley in this vicinity.

The terrace level has been named the Bath Terrace after the town of Bath in Mason County to the north where it is also well-developed. The deposition of the Bath sediments was only one of many events in the long history of the Illinois Valley. This history is much too complex to describe in detail at this time, but several events warrant discussion. The Illinois Valley served as a major meltwater channel throughout the Ice Age. Great valley trains of glacial outwash were deposited in the valley during each of the major glaciations of Illinois. After deposition, each of these valley trains was later re-excavated or drastically modified by erosion during interglacial intervals or by meltwaters during the glaciations. Valley filling may have reached its greatest extent during Woodfordian time when the glacier stood at the position of the Bloomington Moraine about 18,000 years ago (see map of Glacial Geology of Northeastern Illinois). At that time meltwater transported a great quantity of outwash downvalley and built an enormous fan of sand and gravel from Peoria to past Beardstown. The valley bottom was filled to levels exceeding 500 feet above sea level in the Havana area to the north. The valley must have been filled to a level of at least 470 feet and perhaps higher in the Winchester area, although all evidence of this former level has been obliterated by the erosion that followed.

During the stand of the Woodfordian glacier at the position of the Valparaiso Moraine, about 14,000 years ago, an unusually large amount of meltwater poured down the Illinois Valley. This flood, called the Kankakee Torrent, was so great that the waters backed up behind the Woodfordian moraines in northeastern Illinois to form enormous meltwater lakes (see map of Glacial Geology of Northeastern Illinois). The torrential floodwaters scoured and eroded the Bloomington outwash in the Illinois Valley. In the Havana area two terrace levels higher than the Bath Terrace were cut during two stages of the flood. In the Winchester area the floodwaters filled the valley from wall to wall and at their greatest height were as much as 80 feet above the present level of Illinois River. This torrential flood, which probably was brief, eroded the Bloomington outwash from bluff to bluff. No terraces such as those in the Havana area remain in this much narrower segment of the valley. The valley was widened considerably as the water cut back the easily eroded loess bluffs along both sides. The limestone cliffs in the bluffs to the south of here were exposed when the loess cover was stripped away at this time.

When the Wisconsinan glacier was melting back from the Valparaiso Moraine about 14,000 years ago, glacial Lake Chicago, an ancestral stage of Lake Michigan, was formed in the basin between the ice front and the moraine (see map of Glacial Geology of Northeastern Illinois). Overflow from the lake spilled through the Valparaiso Moraine and cut the Des Plaines Valley. The meltwater entered the

Illinois Valley near Joliet and poured downvalley as another great meltwater flood. This meltwater rapidly cut down the outlet channel and greatly deepened the Illinois Valley east of the Big Bend in Bureau County. In the Winchester area the valley was filled to the level of the Bath Terrace with sand and gravel eroded from upstream. As the flood waned, the river began to deepen its channel and cut away part of the fill, forming the Bath Terrace. A second stage of overflow from Lake Chicago occurred during the stand of the Valderan glacier about 10,000 years ago. This overflow resulted in further erosion of the valley train, perhaps as much as 50 feet below the present floodplain. During the last 7,000 years the river has been aggrading, filling the valley to its present level.

The excavation of this pit has exposed approximately 30 feet of reddish brown to tan, medium to coarse-grained, unconsolidated sand. The sand is thinly and evenly bedded (layered), well-sorted, fairly well-rounded, and contains little gravel. About 8 feet above the base of the pit is a layer of greenish gray, massive, sandy clay. The sand immediately above and below the clay bed is very clayey and tough for several inches. Laterally the clay bed lenses out at both ends of the pit.

The even bedding of the sand indicates deposition by strong, but steady currents. Cross-bedding and cut-and-fill structures characteristic of alluvial deposits are absent. This indicates deposition adjacent to the main axis of flow which was probably to the west nearer the middle of the valley. The clay bed indicates very quiet water, probably a pond that formed on the surface of the valley train when the channel shifted to the west side of the valley. It may also indicate a short interruption in sand deposition because of a temporary waning of the Lake Chicago floodwaters.

History of Illinois Valley

The Illinois Valley had its origin during the early part of the Ice Age about 1,000,000 years ago. There is little evidence to indicate exactly what the drainage system in this region was like before that time. However, major drainage at the beginning of the Pleistocene Epoch seems to have been northward, not southward as at the present time. With the advance of the Nebraskan glacier, the first of the glacial advances, from the northwest, the northward-draining rivers were blocked by the ice. Nebraskan meltwater was forced to seek a southward escape route, and a major meltwater channel was eroded around the eastern margin of the Nebraskan glacier. This valley entered northwestern Illinois near Fulton in Whiteside County from where it extended southeastward to the present "Big Bend" of the Illinois Valley near Hennepin. From there it followed approximately the present course of the Illinois Valley to a junction with another meltwater valley (the Ancient Iowa River) near Grafton in Calhoun County. By the end of the Nebraskan glaciation the valley had been permanently established. For most of Pleistocene time the valley was occupied by an ancestral stream called the Ancient Mississippi River. The valley was deepened and widened by the Ancient Mississippi during the Nebraskan glaciation, the Aftonian interglacial interval, and the Kansan glaciation. Evidence indicates that the valley was cut to its greatest depth by the time the Kansan glacier invaded Illinois.

The Ancient Mississippi continued to follow its course to the Big Bend until the valley was overridden by the advance of the Wisconsinan glacier in the early part of the Woodfordian glaciation some 20,000 years ago. This advance, called the Shelbyville, forced the Ancient Mississippi River westward where it cut through a bedrock divide at Cordova south of Fulton and joined the valley of the Ancient Iowa

River, the course it now follows along the western side of Illinois. The valley from Fulton to the Big Bend was filled by Shelbyville drift and permanently abandoned. The upper Illinois Valley east of the Big Bend was then cut by meltwater during the numerous advances and retreats of the Woodfordian glacier and by overflow from glacial Lake Chicago. It is interesting that although the Ancient Mississippi Valley had been overridden by the advances of the Illinoian glacier and partially filled by drift, westward diversion of the river was temporary. Only relatively minor changes in the position of the valley took place. After the Illinoian glacier melted the Ancient Mississippi River was able to return to its course to the Big Bend and then southward through the Illinois Valley.

Leave Stop 1. Return to highway.

- 0.15 4.65 STOP. Turn right (west) on Route 36.
- 0.35 5.0 Note the ridge extending towards the northwest from the sand pit at Stop 1.
- 0.7 5.7 Cross another low-lying bar. This bar is on the floodplain of the Illinois River. It consists of Recent alluvium and is not part of the Bath Terrace. It was formed by floodwaters after the valley was aggraded to its present level during post-glacial time.
- 0.9 6.6 Intersection with Route 100. Turn right (north).
- 0.7 7.3 On the right in the distance, note the rounded, loess-covered bluffs on the east side of Illinois Valley.
- 0.4 7.7 Cross Walnut Creek.
- 1.2 8.9 Crossing the undulating surface of the Bath Terrace.
- 1.4 10.3 The Bath Terrace slopes noticeably westward in this vicinity.
- 1.4 11.7 Enter valley of Mauvaise Terre Creek.
- 0.2 11.9 T-road from right. Turn right (east).
- 0.3 12.2 Enter village of Oxville.
- 0.2 12.4 Ascend to upland.
- 0.55 12.95 Y-intersection. Bear left (east) on gravel road.
- Descend into sharp valley.
- 0.25 13.2 Cross culvert and STOP.

Stop 2. Exposure of Mississippian Warsaw Shale in narrow valley north of road (NW 1/4 SE 1/4, Sec. 33, T. 15 N., R. 13 W.).

For several hundred feet to the north a tributary to Mauvaise Terre Creek has cut a scenic gorge into the Mississippian Salem, Sonora, and Warsaw Formations. The strata exposed are illustrated in figure 8.

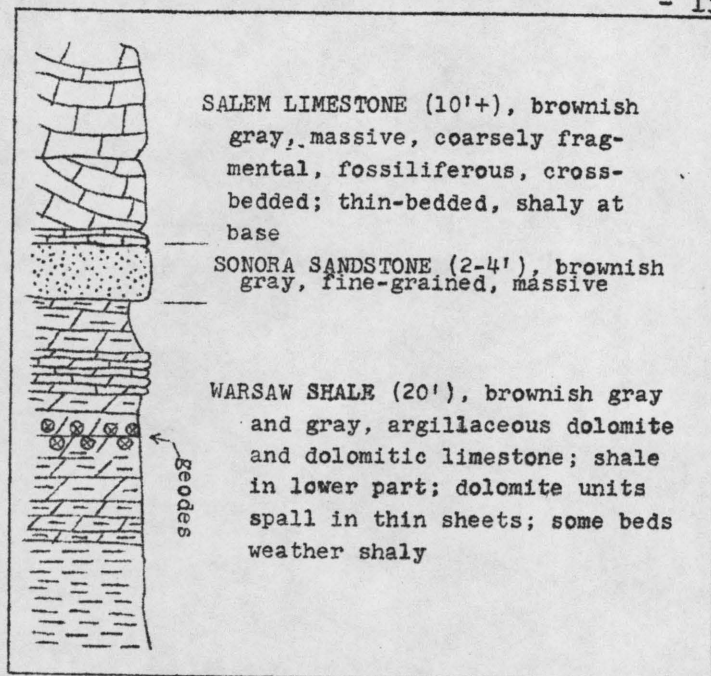


Fig. 8 - Strata exposed at Stop 2.

In this region the Warsaw Shale consists of about 100 feet of gray argillaceous (clayey) dolomite, dolomitic limestone, and gray to bluish gray, dolomitic shale. Shale predominates, especially in the lower part of the formation. Most of the upper part of the Warsaw exposed here consists of very argillaceous dolomite. The rock is sparsely fossiliferous indicating that the muddy conditions in this region were not generally suitable for most bottom-dwelling marine animals. A thin-bedded limestone unit, about 3 feet thick, that occurs near the top of the formation here is very fossiliferous and contains wavy, laminated algal beds. For a time the sea cleared enough so that these organisms could live in this vicinity.

The Warsaw is overlain by 2 to 4 feet of the Sonora Sandstone. The sandstone is resistant to erosion and forms a ledge in the creek bottom over which a small waterfall spills just north of the road. It forms a prominent overhang in the creek bank farther downstream. The Sonora has a maximum thickness of about 10 feet in the Winchester area and represents sands that were spread southeastward onto the western shelf of the Illinois Basin. Greater thicknesses of the sandstone occur northwestward toward the source of the sand. North of Hamilton in Hancock County the formation reaches a thickness of 60 feet and was once quarried for use as building stone. The sandstone interfingers with and grades laterally into the Salem Limestone and the upper beds of the Warsaw Shale. There were no interruptions in the deposition of these formations as the region remained continuously submerged by the Mississippian sea. The contacts between the formations are termed conformable by geologists.

The Salem Limestone consists of gray-brown, relatively pure, coarsely fragmental limestone. In contrast to the muddy conditions during deposition of the Warsaw Shale, the sea was clear when the Salem was deposited. The Salem is very fossiliferous, but most fossils are broken and worn. The limestone is also cross-bedded. These features indicate a shallow environment in which wave-generated currents swept over the sea bottom.

Geodes occur in the Warsaw Shale in this exposure in a 1-foot zone about 6 feet from the top of the formation. All are quartz-lined. They range in size from less than 1 inch to about 4 inches in diameter. Most of the geodes are irregularly shaped and poorly formed, but some fairly good specimens with excellent quartz druses can be collected. Geodes from the lower part of the Warsaw Shale in the vicinity of Warsaw, Illinois, are highly prized by amateur mineral collectors. Most crystal linings of the geodes consist of quartz, calcite, or dolomite, but a variety of other minerals have been found. The origin of the geodes has long puzzled geologists, and several explanations have been proposed. All that is clear is that somehow cavities were formed in the rock, and the crystals then grew inward from the walls of the cavities. Many geodes were completely filled by the crystals and are solid.

Leave Stop 2.

Note the loess exposure in the roadcut on the left.

0.85 14.05 Y-intersection. Turn left (north) just before bridge.

Note the green shale (Warsaw) in the creek bank on the right.

0.45 14.5 Bridge over Mauvaise Terre Creek. Note the flatness of the valley bottom.

1.25 15.75 Crossroads. Turn right (east) on gravel road.

In this vicinity the highway follows the top of a narrow, sinuous ridge that extends for three miles from the vicinity of Exeter westward to the Illinois Valley. The ridge consists of stratified outwash as much as 60 feet thick overlain by Wisconsinan loess, as indicated by borings made along its crest. The outwash overlies Illinoian till of the Jacksonville Substage. The ridge represents an esker-like channel deposit of a meltwater stream that flowed westward through a crevasse at the base of the Illinoian glacier. Its preservation indicates that the Jacksonville ice had stagnated (stopped moving) before it finally melted from the field trip area.

0.1 15.85 STOP. Intersection with blacktop. Continue ahead (east) on blacktop.

1.15 17.0 Silty dolomite beds of the Warsaw Formation in creek bank on the left.

SLOW. Prepare to turn left.

0.2 17.2 Turn left on access road to clay pit.

0.05 17.25 Stop 3. Exposure of Pleistocene and Pennsylvanian strata in clay pit north of highway (SW 1/4 SE 1/4, Sec. 23, T. 15 N., R. 13 W.).

This clay pit, excavated in the north bank of Mauvaise Terre Creek, has exposed an excellent section of lower Pennsylvanian sedimentary rocks overlain by Pleistocene drift deposits of Illinoian and Wisconsinan ages. The pit was operated by the Alsey Refractories Company to obtain clay from the Cheltenham Clay Member of the Spoon Formation. Because the thick Wisconsinan loesses so effectively cover the bedrock surface and so easily weather and slump in natural exposures, artificial exposures such as this one afford unusual opportunities to examine the older drift and bedrock of the Winchester area. The tendency of the unconsolidated Pleistocene deposits to slump is quite evident in this clay pit. Several small landslides have occurred in recent months. A section of strata exposed in a relatively undisturbed, east-facing slope at the north side of the pit are illustrated in figure 9.

Pleistocene Section

The till in this locality is Illinoian in age. The Illinoian glacier covered the Winchester area in two separate advances--the Liman and the Jacksonville (fig. 6). Both of these glaciers advanced southwestward into Illinois from the Labradorian center. The Liman advance was especially strong and represents the most extensive advance of all of the Pleistocene glaciers into the Midwest. It covered 80 percent of Illinois, at its maximum extent pushing southwestward as far as St. Louis and southward to Carbondale, more than 125 miles south of the Winchester area. In the field trip area the glacier crossed the Illinois Valley to a line 12 to 15 miles past Winchester (see Itinerary Map). The Jacksonville advance was also quite strong, but it barely overrode the east bluff of the Illinois Valley in the

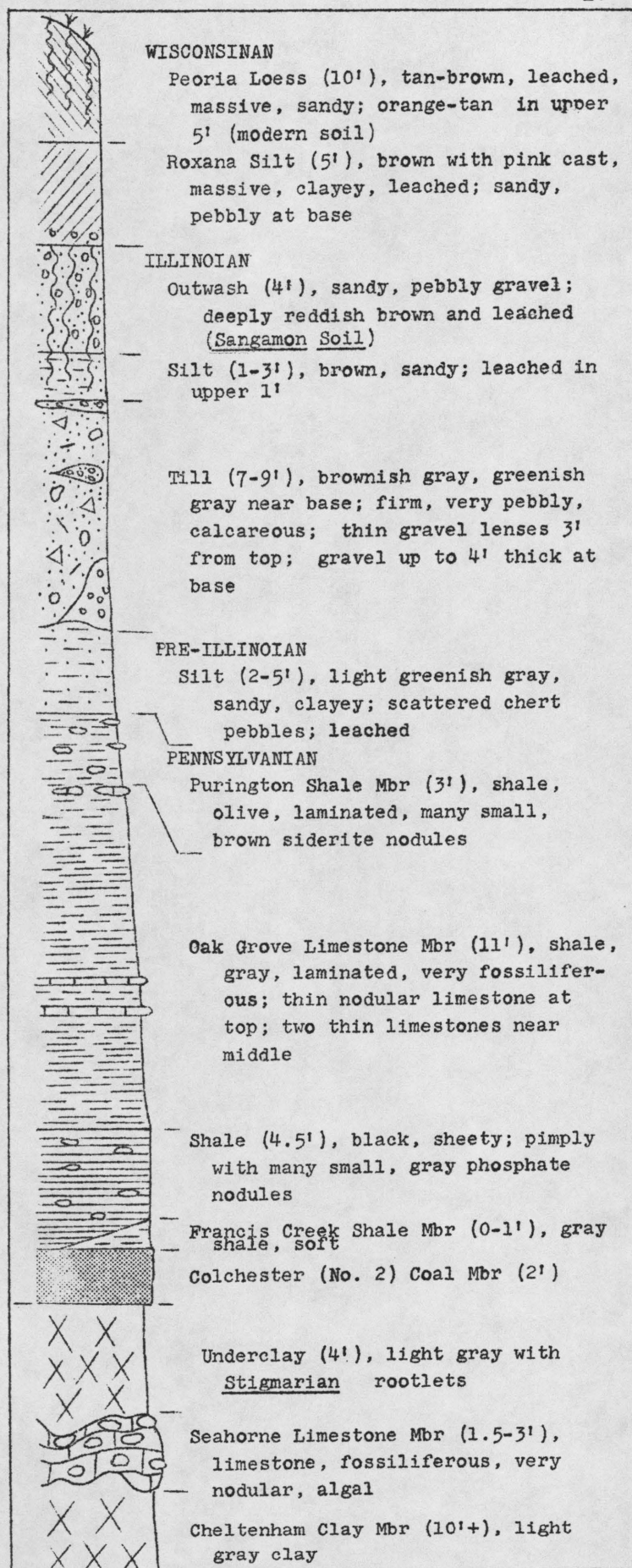


Fig. 9 - Strata exposed at Stop 3.

field trip area. A third advance of the Illinoian glacier--the Buffalo Hart--did not cover the field trip area but advanced only to the vicinity of Springfield about 50 miles to the northeast of here.

The Nebraskan glacier did not extend very far into Illinois. The Kansan ice entered Illinois from both the east and west. Only the ice from the eastern Labradorian center seems to have reached the field trip area, covering the southeastern portion of Scott County. Till of Kansan age is exposed in the bank of a tributary to Sandy Creek two miles southeast of Winchester.

The till exposed here was probably deposited by the Jacksonville glacier. Till is an ice-laid material, deposited while the glacier was still moving. It was deposited by a kind of plastering action as rock debris was released by melting at the base of the glacier. Till is characterized by its massive, unstratified structure and by its unsorted texture, consisting of a random mixture of clay, silt, sand, gravel, and larger-sized rock debris. Boulders are common because glacial ice has virtually unlimited transporting power. Tills consist of rock debris eroded from the areas over which the glaciers moved. In addition to locally derived rock debris, the tills in Illinois contain a large variety of igneous and metamorphic rocks that were eroded from areas in Canada and carried hundreds of miles by the glaciers. The Jacksonville till contains many pebble and cobble-size rock fragments. Many of these are faceted (flattened on one or more sides) and striated (scratched) because of abrasion during transport by the ice. The rocks were held firmly by the ice and were ground against each other and dragged along the frozen ground over which the glacier moved. These features are best exhibited by fragments of fine-grained, dense limestone.

The Illinoian till is overlain by a thin bed of sandy silt that was deposited in a small pond that

existed for a short time when the glacier melted. Sand and gravel above the silt were also deposited by meltwater of the Jacksonville glacier. The outwash and the upper part of the silt have been deeply weathered and are leached of carbonate minerals. The gravel is a brilliant reddish tan color and forms a conspicuous band across the face of the exposure. This weathered zone is the Sangamon Soil, an ancient buried soil that was formed during the warm interglacial interval that followed the Illinoian glaciation. This interval of weathering, called the Sangamonian, lasted from about 200,000 to 70,000 years ago. The reddish color of the soil in this immediate locality indicates that it was developed under well-drained conditions.

The Sangamon Soil is extensively developed on the Illinoian glacial deposits throughout the Midwest. The soil is an important stratigraphic marker in areas of thick drift where more than one till layer is present. Where drift units above and below are not completely leached, the soil zone can be detected by testing with dilute acid (HCl). Unleached till bubbles when acid is applied due to a reaction with carbonate minerals (calcite and dolomite). Carbon dioxide gas is given off. The silt and till exposed here are calcareous below the soil zone, but the loess above the soil has been leached by post-Wisconsinan weathering.

The Wisconsinan glacier did not reach the Winchester area. At its greatest extent during the Woodfordian advance, the glacier stood at the Shelbyville Moraine 75 miles to the northeast in Macon and Shelby Counties. However, during the Wisconsinan glaciation loess was deposited far beyond the areas covered by the ice. The Roxana Silt and the Peoria Loess are loess deposits that record events of the Wisconsinan glaciation in this area. The loess deposits, consisting principally of very fine, powdery silt, were laid down by the wind. The silt was eroded from outwash in the Mississippi and Illinois Valleys.

There were two major advances of the Wisconsinan glacier into the Midwest. These advances, called the Altonian and The Woodfordian, both entered Illinois from the northeast (fig. 6). The Roxana Silt, the lower loess in this exposure, was deposited during the advance and retreat of the Altonian glacier between 70,000 and 28,000 years ago. During the Altonian glaciation meltwater from the ice front deposited a thick valley train in the Illinois Valley. Wherever it occurs, the Roxana has a characteristic pinkish brown color. The Roxana is typically 5 to 10 feet thick on the upland in the field trip area.

The Peoria Loess was deposited mainly during the advance and retreat of the Woodfordian glacier between 22,000 and 12,000 years ago. During the Woodfordian glaciation great amounts of meltwater again flowed down the Illinois Valley and deposited another thick valley train of outwash. A slight amount of loess deposition also occurred during the Valderan glaciation from 10,000 to 7,000 years ago. The Peoria Loess is typically tan in color. It is as much as 50 feet thick on the Illinois Valley bluffs to the west. The contact between the Peoria Loess and the Roxana Silt is difficult to see. However, by standing back from the exposure the color differences are quite evident.

The Illinoian till in this locality does not rest on the Pennsylvanian shale but is underlain by a few feet of light greenish gray, finely blocky, sandy silt. The silt is non-calcareous. A glacial origin for the silt is indicated by its sharp boundary with the shale, the presence of coarse quartz sand, and scattered pebbles of quartz and chert. Because the silt is leached, it is probably of pre-Illinoian age, most likely Kansan. If so, it was deposited in a glacial pond formed by meltwater while the Kansan glacier stood a few miles to the southeast. Leaching of the silt would have taken place during the Yarmouthian interglacial interval that followed.

Pennsylvanian Section

Portions of two Pennsylvanian formations and at least two cyclothems are exposed below the glacial deposits. The strata below the Colchester (No. 2) Coal Member belong to the Spoon Formation. The coal and overlying bedrock belong to the Carbondale Formation. These two formations comprise the Kewanee Group. The thinness of the rock units illustrates the diverse sedimentary conditions that existed in this area during their deposition.

As is typical elsewhere, the cyclothems exposed here do not contain all 10 units of the ideal cyclothem. Some units were never deposited because the changes from marine to nonmarine environments, and vice-versa, were extremely abrupt and frequent. During periods of emergence, strata were removed by erosion. Sedimentary conditions in the Winchester area during the Pennsylvanian Period were less variable at times than in areas in the deeper parts of the Illinois Basin. Emergent conditions and erosion or nondeposition appear to have been prevalent much of the time because of the effect of the Pittsfield Anticline and the Mississippi River Arch just to the west. The Pennsylvanian strata thin toward the axes of these structures, suggesting that movements of the structures may have been taking place during early Pennsylvanian time. The area over the structures must have been topographically higher than adjacent areas and thus received less sediment. Near Pittsfield, about 20 miles to the southwest, the interval between the No. 2 Coal and the underlying Mississippian strata is as little as 4 feet while in the field trip area the interval may be as much as 25 feet or slightly more. The interval between the No. 2 Coal and the base of the Pennsylvanian in the deepest part of the Illinois Basin is as much as 1,200 feet. This much greater thickness of strata accumulated there in the same amount of time because of the greater amount of subsidence of the basin.

From the Beardstown Quadrangle southward to the St. Louis area, the Cheltenham Clay Member is an interesting development in the lower Pennsylvanian strata. Most of the coals, shales, and sandstones of the Spoon Formation wedge out southward so that the underclays from several cyclothems appear to be superposed one above another. In some instances rather distinct color bands separated by thin carbonaceous films can be found in the clay. The carbonaceous films represent the position of coals that did not develop. Conditions of deposition must have remained fairly stable for a considerable length of time for the accumulation of so great a thickness of fine clay. Because the clay also contains quartz, it is a refractory material (this is discussed later in the itinerary).

The Seahorne Limestone Member has a distinct, easily recognizable appearance. Irregular, dark gray, algal limestone nodules and biscuits in a lighter brownish-gray algal matrix gives the rock a conglomeratic or brecciated character. The texture is characteristic of algal limestones. Some of the masses show a septarian structure with the joints being filled with calcite and siderite crystals. The lower surface of the limestone is also highly irregular. Fossils noted in the dark gray limestone include Chonetes granulifer, Mesolobus mesolobus, Phricodothyris, Marginifera muricata, Composita, branching Bryozoa, crinoid stem fragments, and occasional small corals.

The No. 2 Coal is one of the most widespread of the economically important coals in Illinois. It is extensively mined in western and eastern Illinois where it reaches a thickness of 2 to 3 1/2 feet. As seen here, the coal has been extensively mined in this locality many years ago. Although the coal does thin toward Pittsfield and other more western localities in Illinois, the thickness observed here and to the north and northwest is minable. A large strip mine in southwestern Fulton County

and another strip mine along the Illinois River also in Fulton County have operated in the No. 2 Coal for a number of years and represent the closest large-scale operations.

The designation of the coals in Illinois by number began in the middle 1800's when geologists recognized that the coals were widespread and rather easily identified. They numbered the coals, the lowest and oldest coal designated No. 1, in an attempt to better understand and interpret the Pennsylvanian strata. The coals were numbered consecutively from the oldest (lowest) to youngest (highest) in the section. Later, geologists discovered additional coal beds that had not been recognized previously, thus adding confusion to the numbering system. Letter-number combinations were used for a while, but it was finally decided to use geographic names in accordance with the standard practice of stratigraphic nomenclature. However, because of long usage, the numbers along with geographic names are still used for the more widespread, commercially important coals.

The Francis Creek Shale Member is a gray, pyritic shale that occurs immediately above the No. 2 Coal (unit 6 of the ideal cyclothem). Locally plant fossils may be found near the base; marine fossils are rare. As observed here, the shale is lenticular in occurrence, locally being totally missing so that the hard, slaty black shale lies immediately on top of the coal.

The Oak Grove Limestone Member occurs above the black roof shale of the No. 2 Coal. Although this member consists of as many as 14 distinct marine limestone and shale units elsewhere, perhaps only 5 to 9 thin units here can be assigned to the Oak Grove. Some of the limestone and shale units are exceedingly fossiliferous and, though only a few inches thick, may be traced laterally for miles. Here the limestones are so argillaceous that they readily break down by weathering into masses of fossil debris. Fossils noted include Composita, Crurithyris planoconvexa, Derbya crassa, Chonetes granulifer, Marginifera muricata, Mesolobus mesolobus, branching Bryozoa, crinoid stem fragments, and occasional corals and straight cephalopods.

The lower part of the Purington Shale Member is exposed just below the glacial drift at this locality. It is an olive to gray shale that contains many ironstone concretions throughout. It is unit 10 of the ideal cyclothem.

Leave Stop 3. Return to highway.

0.05 17.3 STOP. Turn left (east).

0.5 17.8 Bridge over Mauvaise Terre Creek. Enter village of Exeter. SLOW.

An excellent exposure of the Mississippian St. Louis Limestone occurs in the bed of Wolf Run, two miles up the road to the left, just before the bridge. About 10 feet of the St. Louis, overlain by the Cheltenham Clay, is exposed.

1.95 19.75 Y-intersection. Bear left (east) onto gravel road.

0.25 20.0 T-road intersection. Continue ahead (east).

1.4 21.4 Crossroads. Bear left and continue ahead (east).

1.0 22.4 Enter village of Merritt. SLOW.

0.1 22.5 STOP. Railroad crossing. Continue ahead (east).

- 0.1 22.6 Crossroads. Continue ahead (east) on oiled road.
- 2.6 25.2 Note Allison Mound ahead to the right.
- 1.0 26.2 T-road from right. Turn right (south).
- 0.3 26.5 Stop 4. Discussion of Allison Mound. Park on right shoulder. Walk to pasture gate near crest of hill on left side of road (NW 1/4 SE 1/4 NW 1/4, Sec. 32, T. 15 N., R. 11 W.).

Allison Mound is a kame-like, ice-contact feature that probably represents another crevasse-filling. It is one of several similar mounds and ridges in this area that includes The Mound 3 miles to the northeast. These two mounds rise rather prominently above the otherwise featureless surface of the Illinoian till plain in this vicinity. This vantage point near the top of Allison Mound affords an excellent view of the till plain to the north, east, and south. The tremendous leveling effect of drift deposition during continental glaciation can be fully appreciated. Allison Mound stands about 80 feet above the till plain, and The Mound rises to a height of over 100 feet.

Like the ridge at Exeter, these mounds are believed to represent constructional features formed when the Illinoian glacier had stagnated. Some of these crevasse-fillings consist almost entirely of till, an ice-laid material. Others consist of outwash or mixtures of till and outwash. Because of this variable composition the origin of these features has been somewhat of a puzzle. For a time the ones in this area, which have a rude east-west alignment, were thought to represent remnants of an eroded Illinoian end moraine. End moraines are formed by moving ice. The present feeling is that they are crevasse fillings as mentioned earlier. Crevasses undoubtedly had formed in the Illinoian ice, and meltwater entering these crevasses would have enlarged them and deposited outwash. Till could also have slumped in from the sides. However, mounds composed entirely of till are not so easily explained.

Note on the Itinerary Map that the topography and the streams of the field trip area have a pronounced linearity toward the southwest. This was the direction of movement of the Illinoian glacier, to which these aspects of the topography and drainage are related. Many of the major trunk streams probably originated as meltwater streams flowing in northeast-southwest oriented crevasses in the ice. As they were gradually let down onto the till plain, they cut valleys which retain the pattern of the crevasse system.

The Illinoian glacier did not build end moraines as prominent as those formed by the Wisconsinan glacier in northeastern Illinois. This fact has been interpreted as indicating that the Illinoian ice front did not maintain static positions long enough to permit end moraines to form, nor were there as many oscillations of the glacier. The Illinoian glacier is believed to have stagnated soon after it reached its maximum extent during each of its advances.

Leave Stop 4. Continue ahead (south).

- 0.6 27.1 STOP. Intersection with Routes 36 and 54. Turn right (west).
- 2.0 29.1 Notice how flat the Illinoian till plain is in this area.
- 1.8 30.9 Enter village of Riggston. SLOW. Railroad crossing.

1.45 32.35 Exeter Road to the west. Continue on Route 36 toward Winchester.

After turning south prepare to turn right into picnic area.

0.65 33.0 Turn right onto gravel access road.

.05 33.05 Stop 5. Lunch in Ebaugh Park picnic and camping area (northwest of center of Sec. 5, T. 14 N., R. 12 W.).

Leave Stop 5. Return to highway.

STOP. Turn right (south) on Route 36.

1.9 34.95 Cross Walnut Creek.

0.75 35.7 Note the high ground on the right in the distance, along the east bluff of Illinois Valley. The rise in elevation toward the bluff line is because of the great thickness of the loess that was deposited there. The loess thins rapidly away from the bluff.

0.4 36.1 Bear left off highway on turn-off to Winchester.

0.2 36.3 Enter Winchester. Continue ahead into town on Main Street.

0.2 36.5 Railroad crossing.

0.55 37.05 3-way STOP. Main Street and Cherry Street. Turn left (east) on Cherry Street (Route 106).

0.35 37.4 Leave Winchester. Prepare to stop east of town.

0.6 38.0 Turn right onto shoulder west of bridge over Big Sandy Creek.

Stop 6. St. Louis Limestone exposed in creek bank south of bridge (NW 1/4 NW 1/4 SE 1/4, Sec. 28, T. 14 N., R. 12 W.).

The Mississippian St. Louis Limestone is exposed in the creek bank south of the bridge. The lower 10 feet of the exposure consists of gray to brownish gray, fine- to coarse-grained, dolomitic limestone in medium to thick beds. One massive bed forms a prominent ledge for a considerable distance along the edge of the creek. The upper 6 feet of the exposure consists of thinner beds which also include laminated algal limestone. Some of these beds are coarsely fragmental and fossiliferous.

Fine-grained limestone that weathers into thin, irregular slabs about 6 feet above the lower ledge contains abundant large, well-preserved solitary corals. As a result of etching of the limestone by weathering, the corals stand in relief on the bedding surfaces. The algal limestone beds and the corals attest to the shallow water conditions that existed during the deposition of the St. Louis Limestone in this area. The St. Louis Limestone is the youngest Mississippian formation in the field trip area.

Leave Stop 6. Continue ahead.

1.8 39.8 Cross tributary to Sandy Creek. Prepare to turn left.

- 0.65 40.45 T-road from left. Turn left (east) on gravel road. Radio tower can be seen about .2 mile ahead.
- 1.1 41.55 T-road from right. Continue ahead.
- 0.95 42.5 T-road from right. Turn right (south).
- 0.9 43.4 Cross Little Sandy Creek.

Note the bedrock exposure across creek on the right. The strata visible from the road include gray-brown conglomeratic sandstone underlain by greenish gray shale containing sand stringers and numerous, very fossiliferous, ferruginous limestone nodules. These strata are Pennsylvanian in age and are older than the Cheltenham Clay. Downstream around the bend to the west, the Pennsylvanian shale overlies gray argillaceous dolomite of the Mississippian Warsaw Shale. This contact is an excellent exposure of the boundary between the Pennsylvanian and Mississippian Systems. Throughout the Midwest this boundary is a major unconformity or erosion surface that represents the long interval of emergence that followed the withdrawal of the Mississippian sea and preceded the advance of the Pennsylvanian sea. Because of beveling of the eastward-dipping Mississippian rocks in the field trip area, the Pennsylvanian strata overlap the erosional edges of the Mississippian formations (fig. 2). In northern Illinois the Pennsylvanian rests on rocks as old as Ordovician.

The sandstone conglomerate contains chert fragments eroded from the Mississippian limestones locally. It also contains geodes from the underlying Warsaw Shale. The conglomerate must rest directly on the Warsaw nearby this locality. Numerous geodes also occur in the gravel in the creek bottom.

- 0.25 43.65 Old drift mines in the No. 2 Coal on the right across the creek.
- 0.15 43.8 Entrance to operating clay mine of Alsey Refractories Company on the left. The Cheltenham Clay is being extracted.
- 0.1 43.9 Spoil piles from old coal mines on the right.
- 0.1 44.0 Stop 7. Exposure of Pennsylvanian Carbondale Formation in creek bank on the right. (NE 1/4 SE 1/4 NE 1/4, Sec. 14, T. 13 N., R. 12 W.).

Pennsylvanian bedrock strata exposed on the east side of the creek are essentially the same as those exposed at Stop 3. However, parts of three cyclothems (Seahorne, Liverpool, and Summum) are exposed here rather than two (Seahorne and Liverpool) at Stop 3. This is an excellent opportunity to compare and contrast approximately the same sequence of rocks in exposures that are about 12 miles apart.

Typical nodular, gray Seahorne Limestone with its conglomeratic to brecciated appearance occurs in the creek bottom. The Colchester (No. 2) Coal, however, averages about 10 inches thicker than at Exeter. The overlying Francis Creek Shale, which is lenticular in occurrence at Exeter, is completely absent here. Discoidal limestone masses and black, slaty, pimply shale directly overlie the coal. The Oak Grove Limestone and Purington Shale beds also are missing from this exposure. These latter units either were not deposited here or, more probably, were eroded away by a distributary channel migrating across the delta front. The Pleasantview Sandstone Member now occupies this ancient channel.

Here the Pleasantview is a gray brown, fine to medium grained sandstone that contains thin, ripple-bedded shale interlaminae near the base. The

sandstone itself is finely ripple-marked, indicating reworking by currents in relatively shallow water. The sandstone becomes coarser grained, more cross-bedded and massive upward in the exposure. The thickest bed, about 4 feet thick, clearly is a channel filling. The Pleasantview is the basal, nonmarine sandstone (unit 1) of the Summum Cyclothem. Elsewhere this sandstone occurs either as sheet sandstone deposits up to 20 feet thick between distributary channels or as channel fillings up to 80 feet in thickness. The Pleasantview rests unconformably on all beds down to the Colchester (No. 2) Coal but is not known to have cut down through the coal.

Scott County has reported coal production for 61 years during the period 1888 through 1942, the last year that coal of record was produced in the county. An estimated 612,476 tons of No. 2 Coal, the only coal mined, were produced during this period.

Pennsylvanian sedimentary rocks form the bedrock surface over approximately four-fifths of Illinois and have a maximum cumulative thickness of about 3,000 feet. They were deposited between 310 and 270 million years ago and contain all of Illinois' minable coal beds, whose recoverable reserves are estimated at 137 billion tons. Coal is one of the state's most important mineral resources, accounting for over one-third of the total mineral production value, which in 1968 amounted to approximately \$670.7 million. In 1968, over 62 million tons of coal valued at more than \$249 million were mined in Illinois, ranking the state fourth among the coal-producing states in the nation.

Leave Stop 7. Continue ahead (south).

- .05 44.05 Y-intersection. Bear right. Do not cross bridge.
- 0.7 44.75 Gas pipeline pumping station on the left.
- 1.05 45.8 STOP. T-road intersection with blacktop. Turn right (west) toward Alsey.
- 2.35 48.15 STOP. Intersection with Route 106. Turn left (south).

Enter Alsey. Cross railroad tracks.

Note the brickyard and kilns of the Alsey Refractories Company on the left.

The Alsey Refractories Company was founded in 1904. In the early days of its operation a 90-foot shaft was sunk to 8 to 10 feet of Cheltenham Clay which was recovered by underground mining methods. This shaft is no longer in operation. Clay is produced from a number of local pits similar to those seen earlier on the itinerary. The plant processes 150 tons of clay per day, half of which is fireclay from Missouri. This is blended with the local Cheltenham Clay to achieve the desired burning properties. The clay blend has a high silica content, mainly because of quartz sand, which limits its use to refractory purposes.

The clay, which is burned at 2,300° F. in beehive and tunnel kilns, yields a light, buff-colored product. Refractory bricks are made for chimneys, kiln liners, bottom liners for tunnel kiln cars, foundry brick, and for backing bricks behind fire-bricks in steel furnaces. The bricks are custom-made to each user's particular needs. Refractory bricks produced in this plant are shipped throughout the world.

The value of clay products reported produced in Illinois during 1968 was \$53.6 million, about 8.0 percent of the total value of all mineral production for

the state that year. Forty-one clay products plants in 24 counties throughout Illinois reported production for the year. Scott County ranked 17th in production among the clay-producing counties.

Turn right on first street (west).

Bear left on first street after turning right off highway.

0.4 48.55 T-road intersection. Turn right (south).

The homes on the right are from brick that was especially made here at the Alsey plant.

1.85 50.4 Crossroads. Continue ahead (west) toward Glasgow.

0.7 51.1 Enter village of Glasgow. Continue ahead (west) through town.

1.6 52.7 Descending into Sandy Creek Valley.

1.0 53.7 STOP. T-road intersection with blacktop. Turn left (south).

0.8 54.5 On the left note the steep face in the loess containing numerous swallow-holes. Under well-drained conditions loess has a tendency to stand in vertical faces because of its compact, homogeneous texture. This property is also related to the shape of the silt particles that make up the loess. The particles are angular and are packed in an interlocking fashion which tends to hold the loess together.

0.4 54.9 Mississippian Burlington Limestone exposed in the bluffs on the left. Several small caves occur in the bluffs in this area.

0.6 55.5 Active quarry in Burlington Limestone on the left. Continue ahead (south).
SLOW. Prepare to turn left.

0.2 55.7 Turn left into entrance to abandoned quarry.

Stop 8. Quarry in Mississippian Burlington Limestone (SW 1/4 SE 1/4 SW 1/4, Sec. 35, T. 13 N., R. 13 W.). Walk south to enter the quarry.

This quarry exposes about 70 feet of the Mississippian Burlington Limestone, the oldest of the Paleozoic formations that will be seen on the field trip. The Burlington consists predominantly of light gray to buff-colored, very coarsely fragmental limestone. It also includes beds of brown to reddish brown dolomite and dolomitic limestone. The limestone is very cherty, a property that is characteristic of the Burlington. The chert is light gray to white and consists of thin layers and bands of discoidal nodules. The limestone is very fossiliferous but most fossils are broken and abraded. Some beds consist entirely of broken fossil fragments indicating the shallow-water conditions that existed during its deposition. Fragments of crinoids are especially abundant. The Burlington Limestone and the Keokuk Limestone, which occurs stratigraphically above it in this region, represent an enormous bank of crinoidal and other fossil debris that accumulated on the western shelf of the Illinois Basin.

Fossil collecting in the Burlington is not especially good because of the broken condition of the fossils. However, crinoid stem discs, calyx fragments, and

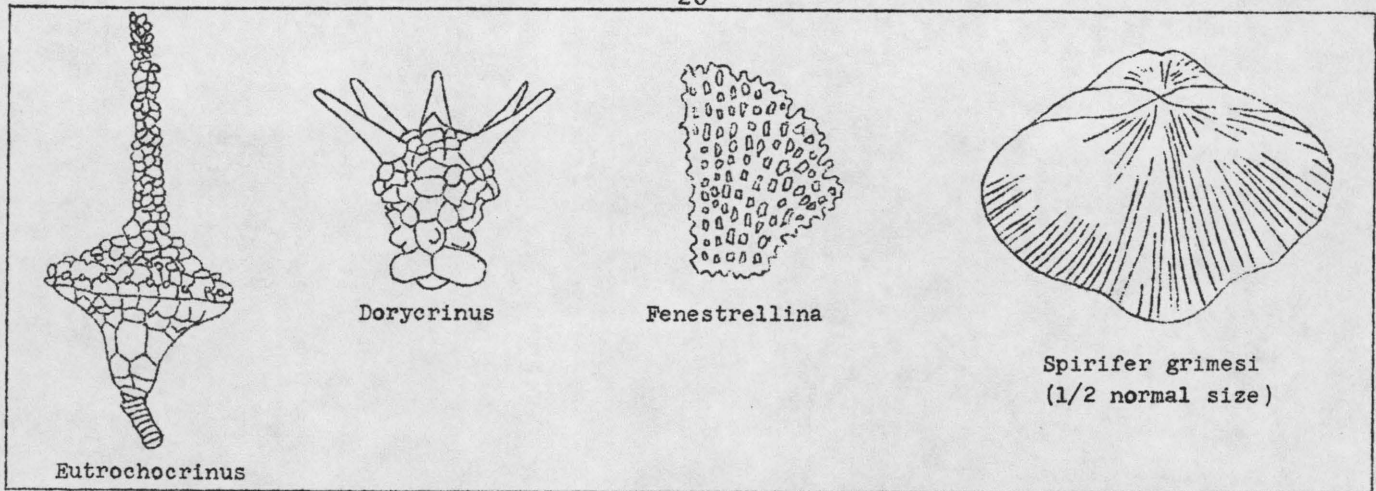


Fig. 10 - Four fossils that occur in the Burlington Limestone.

occasionally complete calyces can be found. The crinoids belong to the phylum Echinodermata and are sessile animals with a cup-like calyx and tentacles supported by a long segmented stem that attaches the animal to the sea floor. Modern crinoids are often referred to as "sea lilies" because of their plant-like appearance. After the animal dies, the stem and calyx easily break apart. Other fossils in the Burlington include brachiopods, bryozoans, and corals. Especially interesting is the large brachiopod, Spirifer grimesi. Figure 10 illustrates this fossil and two species of crinoids that are common in the Burlington. The coarse limestone is a very attractive rock and warrants collecting for this reason alone.

The chert in the limestone is an impurity and reduces its quality as a source of crushed stone. Because of its great hardness, the chert is also destructive to mining and crushing equipment. The origin of the chert is not completely understood by geologists. The chert was apparently not deposited in its present form at the same time as the limestone. Evidence for this is the fact that the chert is fossiliferous and also exhibits many of the sedimentary structures that are in the limestone. Thus the chert appears to have replaced the limestone. Colloidal and finely-divided silica were probably deposited as the siliceous hard parts of sponges and microscopic plants and animals. Later, after solidification of the limestones, this disseminated silica was dissolved, concentrated by solution, and redeposited as the irregular bands and nodules that are now present.

The lower part of the Burlington in this quarry includes an almost chert-free zone of light gray to white limestone about 20 feet thick. An entry to mine this rock underground was started but was abandoned. This relatively pure limestone in the lower part of the Burlington is referred to as the "Quincy Beds." The "Quincy Beds" are mined underground near Quincy, 50 miles to the northwest in Adams County, where they form the basis for the high-purity limestone industry in that area. The limestone is used for roadstone and agricultural lime, and is also burned to make cement and chemical lime.

Leave Stop 8. Turn right and return to the north on blacktop.

2.45 58.15 Cross Sandy Creek.

0.35 58.5 Notice the loess knobs on the bluffline to the right. Some are loess-mantled bedrock promontories, but most consist entirely of loess. Some represent large slump blocks of loess that broke away from the bluff when it was being cut back during the meltwater floods of the Wisconsinan glaciation. Others are simply erosional knobs. Knobs similar to these occur for several miles in this area.

- 0.6 59.1 A narrow remnant of the Bath Terrace is preserved along the side of the valley in this vicinity.
- 0.4 59.5 Note the low sand ridge on the left. A blowout has formed where the vegetation cover has been broken by cultivation. Disturbance of the sandy floodplain sediments in this vicinity has resulted in a serious wind-erosion problem.
- 3.75 63.25 STOP. Intersection with Routes 36 and 54. Turn right (east).
- .15 63.4 Quarry entrance on right. Turn right and enter quarry.

Stop 9. Quarry in Mississippian Salem Limestone (E 1/2 NE 1/4 SE 1/4, Sec. 27, T. 14 N., R. 13 W.).

About 30 feet of the Salem Limestone has been quarried here. The rock is a brownish-gray to brown, dolomitic, fine to coarsely fragmental fossiliferous limestone. A few algal beds are deep reddish tan. In the lower third of the quarry some zones contain quartz-filled vugs up to 3 inches in diameter. The east quarry face shows cross-bedding and channeling about 15 feet above the quarry floor. The highly fossiliferous beds are located close to the quarry floor and contain large spiriferid brachiopods, greenish Fenestrellinid bryozoans, and Foraminifera.

The thick Mississippian limestones along the Mississippi and Illinois River Valleys are the basis of an important quarrying industry. Limestone is also one of Illinois' more important mineral commodities. In 1968, approximately 52.7 million tons of crushed limestone and dolomite valued at about \$77.2 million were produced by Illinois quarry operators. Scott County ranked 47th out of 61 counties reporting stone production for 1968. Principal uses for this stone were as concrete aggregate, roadstone, and agricultural limestone.

A thick section of Pleistocene deposits overlies the Salem Limestone. The exposure changes continually as the bluff is cut back during quarrying operations, so only a general summary of the deposits that have been observed here can be given. The drift units are essentially the same units seen earlier at Stop 3. The principal differences are thicknesses of individual units. The reddish Sangamon Soil is also present. Below the till, which is Jacksonville in age, non-calcareous silt is again present, but much thicker. These pre-Illinoian (?) deposits also include a few feet of pebbly sand. Immediately above the bedrock is a tough, sandy, reddish brown silt along the top of which a series of springs emerge.

Because of the nearness to the Illinois Valley, its source, the loess is very thick. Both the Peoria Loess and the Roxana Silt exceed 30 feet in thickness. The loess is best exposed and most accessible for examination in a steep face through the loess knob above the south end of the quarry. There, 15 feet of Peoria overlie 30 feet of the Roxana. In order to see the distinctive coloration of the loess, it is necessary to strip the loess face, because both loesses weather pink on the outcrop face. The contact of the tan Peoria Loess with the pink Roxana is quite sharp. Below the surface soil the Peoria is calcareous. The Roxana is also calcareous except in the lower few feet. Both loesses are sandy and also contain pods of cross-bedded dune sand, also because of the nearness to the source of these wind-blown materials. The Roxana here includes a brownish gray unit in its upper part, departing from its typical pink color within this zone. This brown unit is overlain by 3 feet of typically pink Roxana Silt.

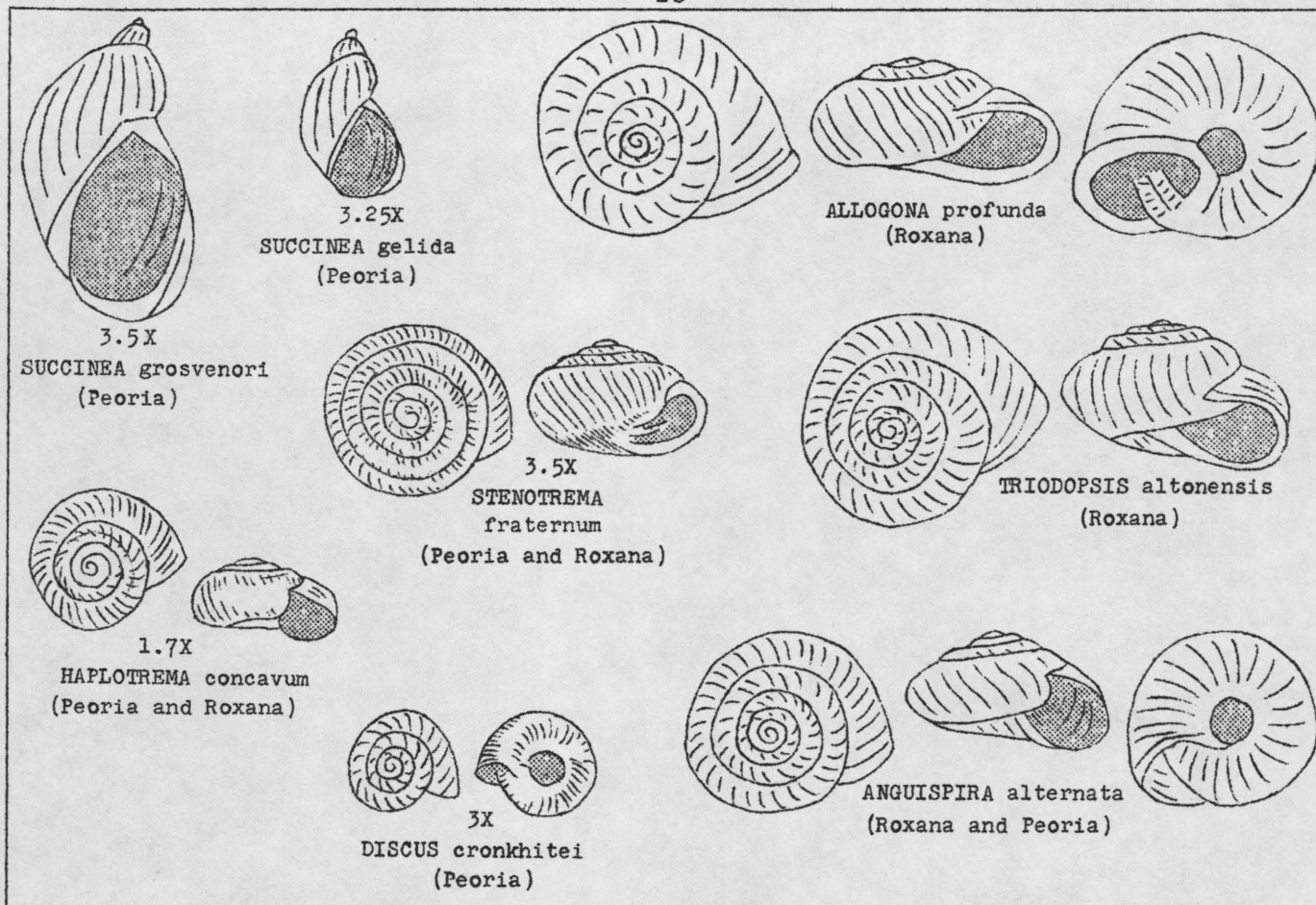


Fig. 11 - Several snail species that occur in the Roxana Silt and Peoria Loess at Stop 9. Natural size except where indicated otherwise.

Of special interest in the loess deposits are numerous, irregular gray concretions and fossil snails. The concretions, commonly called "loess kindchen," are concentrated in the upper half of the Roxana. These concretions are formed by cementation of the loess by calcium carbonate that has been leached from the overlying calcareous loess by downward-percolating water. The calcium carbonate is redeposited as concretions.

The snails in the loess are terrestrial species which lived on the bluffs while the loess was being deposited. When found in abundance the snails are collected and the calcium carbonate of their shells is dated by chemical and radiological analysis of carbon 14. The radiocarbon method has proved useful to Survey geologists in establishing the ages of the loess deposits. Eleven species of snails have been recognized from the Peoria at this locality and 6 from the Roxana. The more common species are illustrated in figure 11. The snails are quite fragile and must be collected with care.

WINCHESTER AREA PROPERTY OWNERS

Stop 1 - James E. Simmons, R. R. 1, Winchester, Illinois 62694 (owner), K. E. Vas Construction Company, Jacksonville, Illinois 62650 (operator); Stop 2 - Orval Hart, R. R. 1, Winchester, Illinois 62694; Stop 3 - Alsey Refractories Company, Alsey, Illinois 62610; Stop 7 - Roland Wallis, R. R. 2X, Winchester, Illinois 62694; Stop 8 - Thomas Quarry, Inc., R. R. 2, Winchester, Illinois 62694; Stop 9 - Mrs. Herman Flynn, R. R. 1, Winchester, Illinois 62694 (owner), Larry Sipes, 231 East Jefferson Street, Winchester, Illinois 62694 (owner and operator), Mrs. James Dwyer, 210 East Jefferson Street, Winchester, Illinois 62694 (operator, Kreuger Quarry).

End of field trip. Thanks for coming!

TIME TABLE OF PLEISTOCENE GLACIATION
(Illinois State Geological Survey, 1969)

STAGE	SUBSTAGE	NATURE OF DEPOSITS	SPECIAL FEATURES
RECENT	Years Before Present	Soil, youthful profile of weathering, lake and river deposits, dunes, peat	
WISCONSINAN (4th glacial)	5,000 Valderan	Outwash	Outwash along Mississippi Valley
	11,000 Twocreekan	Peat and alluvium	Ice withdrawal, erosion
	12,500		
	Woodfordian	Drift, loess, dunes, lake deposits	Glaciation, building of many moraines as far south as Shelbyville, extensive valley trains, outwash plains, and lakes
	22,000		
	Farmdalian	Soil, silt, and peat	Ice withdrawal, weather- ing, and erosion
SANGAMONIAN (3rd interglacial)	28,000		
	Altonian	Drift, loess	Glaciation in northern Illinois, valley trains along major rivers, Winnebago drift
	50,000 to 70,000	Soil, mature profile of weathering	
ILLINOIAN (3rd glacial)	Buffalo Hart	Drift	Glaciers from northeast at maximum reached Mississippi River and nearly to southern tip of Illinois
	Jacksonville	Drift	
	Liman	Drift, loess	
YARMOUTHIAN (2nd interglacial)		Soil, mature profile of weathering	
KANSAN (2nd glacial)		Drift Loess	Glaciers from northeast and northwest covered much of state
AFTONIAN (1st interglacial)		Soil, mature profile of weathering	
NEBRASKAN (1st glacial)		Drift	Glaciers from northwest invaded western Illinois

Revised 1960

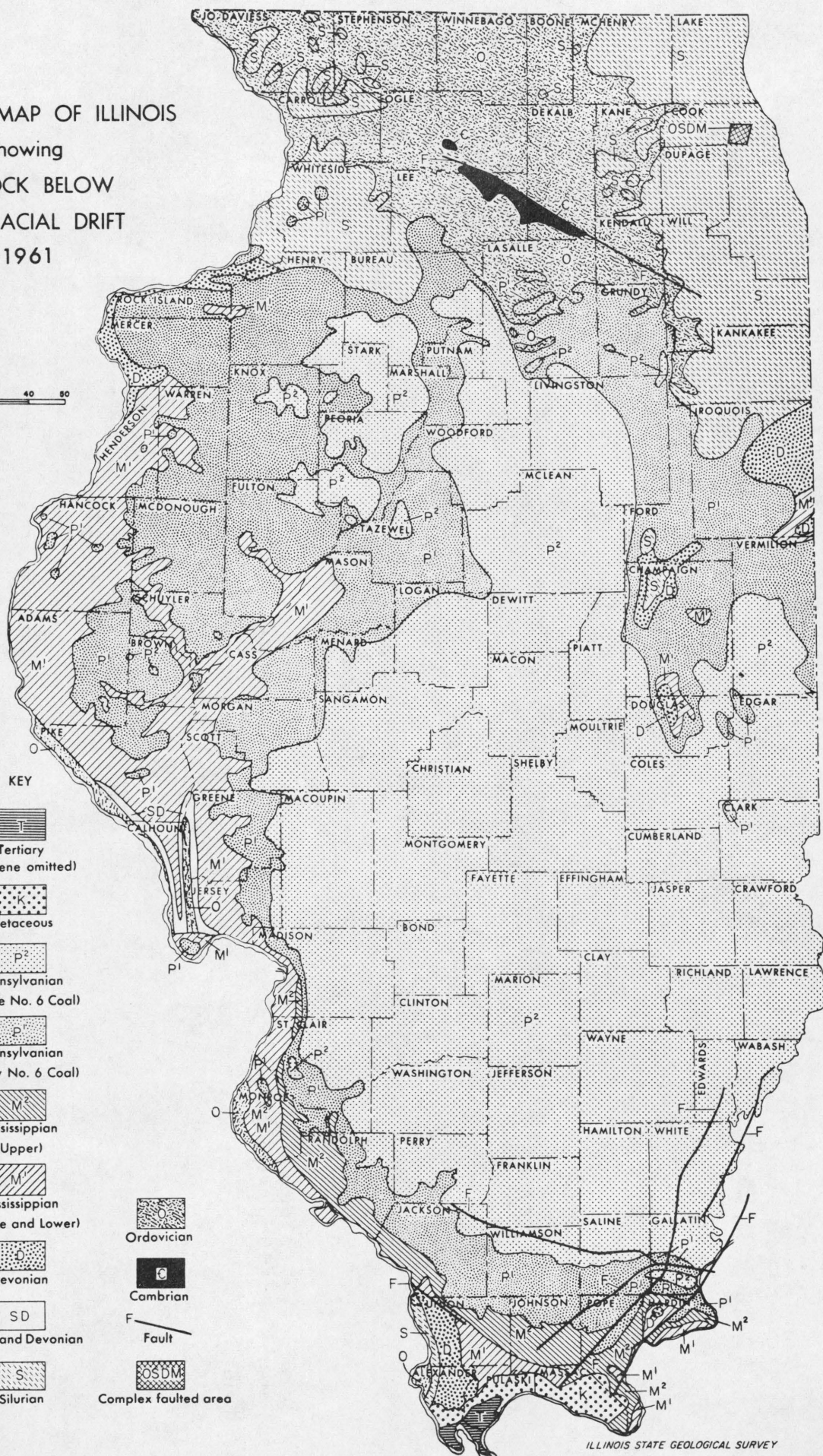
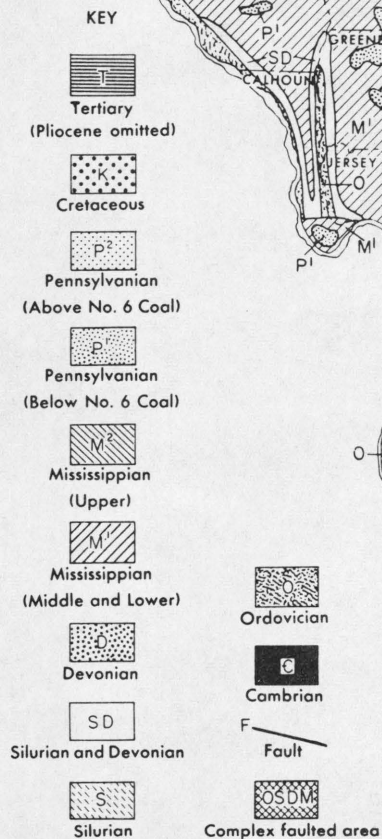
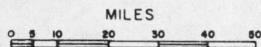
PHYSIOGRAPHIC DIVISIONS OF ILLINOIS



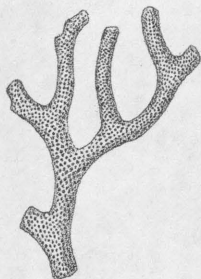
Reprinted 1970

ILLINOIS STATE GEOLOGICAL SURVEY

GEOLOGIC MAP OF ILLINOIS
showing
BEDROCK BELOW
THE GLACIAL DRIFT
1961



BRYOZOANS



Rhombopora 1x



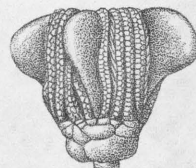
Archimedes 1x

TRILOBITE



Phillipsia 1x

GRINIDS

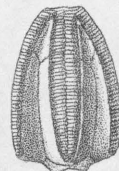


Pterotocrinus 1x



Platycrinus 1x

BLASTOIDS



Pentremites 2x



Pentremites 2/3x

BRACHIOPODS



Composita 1x



Leptaena 1x



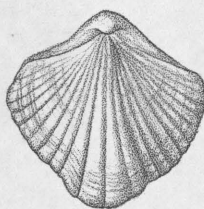
Spirifer 1x



Spiriferina 1x



Triplophyllites 1x



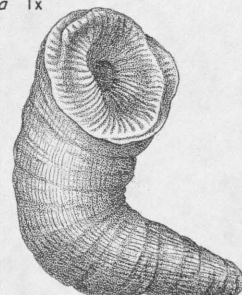
Brachythyris 1x



Pugnoides 1x



Girtyella 1x



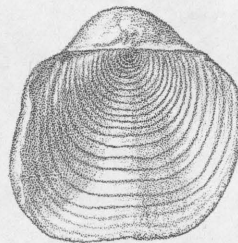
Caninia 2/3x



Orthotetes 1x



Schuchertella 1x

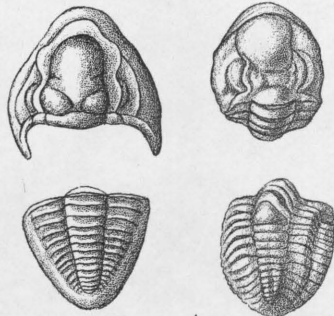


Echinoconchus 1x



CORALS

TRILOBITES



Ameura sangamonensis $1\frac{1}{3}x$

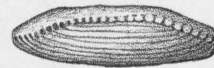
Ditomopyge parvulus $1\frac{1}{2}x$

CORALS



Lophophlidium proliferum $1x$

FUSULINIDS



Fusulina acme $5x$

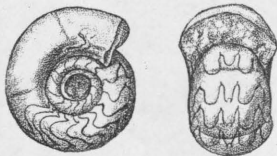


Fusulina girtyi $5x$

CEPHALOPODS

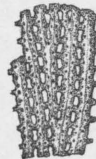


Pseudorthoceras knoxense $1x$

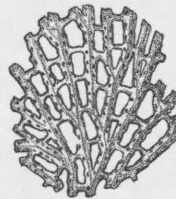


Glaphrites welleri $\frac{2}{3}x$

BRYOZOANS



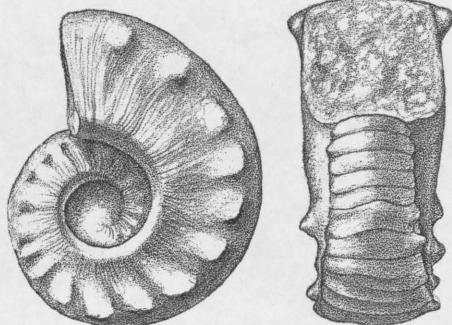
Fenestrellina mimica $9x$



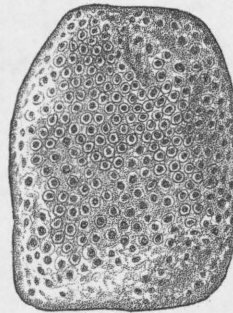
Fenestrellina modesta $10x$



Rhombopora lepidodendroides $6x$



Metacoceras cornutum $1\frac{1}{2}x$

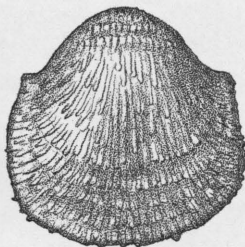
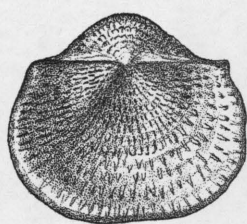


Fistulipora carbonaria $3\frac{1}{3}x$



Prismopora triangulata $12x$

BRACHIOPODS



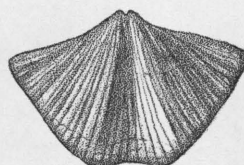
Wellerella tetrahedra 1 1/2 x

Juresania nebrascensis 2/3 x



Derbya crassa 1x

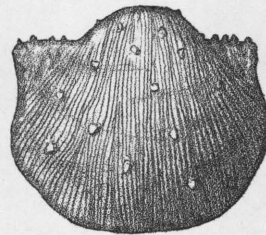
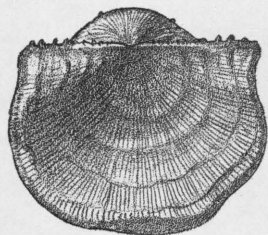
Composita argentic 1x



Neospirifer cameratus 1x



Chonetes granulifer 1 1/2 x *Mesolobus mesolobus* var. *evampygus* 2x *Marginifera splendens* 1x



Grurithyris planoconvexa 2x

Linoproductus "cora" 1x

